



UNDP PAKISTAN.

**Construction of Anti-Narcotics Force (ANF) Academy
Extensions and Women Hostel, Islamabad**

**TECHNICAL SPECIFICATIONS
VOLUME -III**

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TECHNICAL SPECIFICATIONS

A. GENERAL REQUIREMENTS

1) STANDARDS

Where no reference is made to a code, standard or Specifications in Section "B" Specifications of the Contract Documents, the Standard Specifications of the American Society of Testing Materials, (ASTM), British Standard Codes of Practice (BSCP) or any other relevant standard as approved by the ENGINEER shall govern.

2) DRAWINGS

The WORKS shall agree in all particulars with the Drawings or any approved modifications of them or such other drawings as may be issued during the CONTRACT.

The ENGINEER will supply two copies of each of the drawings to the CONTRACTOR free of charge.

The CONTRACTOR will make any further copies required by him at his own expense.

The CONTRACTOR will keep one set of all drawings duly mounted with muslin cloth and hanged on the wooden drawings stand when not in use.

3) CONTRACTOR'S DRAWINGS & DOCUMENTS

The CONTRACTOR shall submit three prints/copies of all drawings, documents and schedules to be prepared by him. These will be of a standard size and format acceptable to the ENGINEER. All such submission by the CONTRACTOR shall be accompanied by a letter of submittal.

4) RECORD DRAWINGS

The CONTRACTOR shall prepare during the progress of the CONTRACT, drawings showing the WORKS "as built" including the positions of all services, plant and equipment. The drawings shall be prepared to a form & detail to the satisfaction of the ENGINEER and prints shall be submitted to the ENGINEER'S REPRESENTATIVE for his approval as the WORKS proceed. At the completion of the CONTRACT the SUB-CONTRACTOR shall supply to the ENGINEER reproducible of each drawing.

5) SUPPLY OF WATER AND ELECTRICITY

The CONTRACTOR shall make his own arrangements for the provision of water & electricity whether for use in the execution and construction of the WORKS or otherwise. In the event of the source of water being from any existing piped supply the CONTRACTOR shall comply with any regulations laid down by the Water Authority and shall pay for such supply, stand-pipe connections, meter rents and all other charges as required all at his own expense. Similarly he will be responsible for all costs in providing electricity. Where electricity is not available for 24 hours, diesel/petrol driven electricity generators in good and reliable condition and of sufficient capacity to meet the requirements of construction equipment and lighting and other facilities at Site will be used by the CONTRACTOR.

6) DISPOSAL OF WASTES

The CONTRACTOR shall make adequate arrangements to the satisfaction of the ENGINEER'S REPRESENTATIVE and as per approved EDF for disposal of all sewage, rubbish and all other waste material arising from or connected with the execution of the WORKS.

7) OTHER SERVICES

The CONTRACTOR shall make his own arrangements for and shall provide any service (including telephone) which may require in addition to the foregoing.

8) BENCH MARKS AND CONTROL POINTS

All levels, lines, grades and measurements shown on the Drawings shall be measured from a Bench Mark and points to be established by the ENGINEER within the Points Site of the WORKS. The CONTRACTOR shall be responsible for ensuring the levels of all parts of the work are accurately related to this Bench Mark which shall be notified to the CONTRACTOR by the ENGINEER immediately after commencement of the WORKS.

9) SURVEY

The CONTRACTOR shall furnish and maintain at his own expense survey instruments stakes and other such materials and give such assistance, including qualified staff as may be required by the ENGINEER who will establish Bench Marks base lines, grades and other principal control points. The CONTRACTOR shall, however, call the ENGINEER'S attention to any inaccuracies and discrepancies of such controlling points etc., before proceeding with the work. The CONTRACTOR shall at his own expense, establish working or construction lines and grades as required, which shall be

frequently checked by the ENGINEER'S REPRESENTATIVE but the CONTRACTOR shall be solely responsible for the accuracy thereof.

10) SAFEGUARDING BENCH MARKS & CONTROL POINTS

The CONTRACTOR shall safeguard all points, stakes, grade marks and bench marks made or established on the work. If disturbed he shall bear the cost of re-establishing them and also the entire Points expense of rectifying the work rendered defective due to such disturbance.

11) PROGRESS PHOTOGRAPH

The CONTRACTOR shall, throughout the construction of the WORKS use digital camera for photography and provide the progress photographs in colour to the ENGINEER. He will also submit three prints each of size 5"x7" along with the recorded data at two week intervals. All such photographs will be taken under the direction of the ENGINEER.

12) MATERIALS AND WORKMANSHIP

As soon as possible after the CONTRACT has been awarded, the CONTRACTOR shall submit to ENGINEER list of suppliers from whom he proposes to purchase the materials necessary for the execution of the WORKS. The information regarding the names of suppliers may be submitted at different times, as may be convenient, but no approved source of supply shall be changed without the prior permission of the ENGINEER'S REPRESENTATIVE.

Preference shall be given to the use of materials and fittings manufactured in Pakistan which comply with the CONTRACT and are competitive in price. Foreign materials shall only be used with the consent of the ENGINEER.

All materials incorporated in the Works shall be new and of the best quality and description of their respective kinds and shall comply with all relevant specifications. Similarly the workmanship in every case shall be of the best character, and the whole shall be subject to the approval of the ENGINEER.

Materials whose quality and construction are not covered by the Technical Specifications shall be of equal or better quality than the relevant sample accepted by the ENGINEER'S REPRESENTATIVE.

13) SAMPLES

In addition to any special provisions herein for the sampling and testing of materials, the CONTRACTOR shall submit to the ENGINEER as he may require samples of all

materials and goods which he proposes to use or employ in or for the WORKS. Such samples, if approved, will be retained by the ENGINEER'S REPRESENTATIVE, and no materials or goods of which samples have been submitted shall be used on the Works unless and until such samples have been approved in writing by the ENGINEER.

The ENGINEER'S REPRESENTATIVE may reject any materials and goods which in his opinion are inferior to the samples thereof previously approved and the SUB-CONTRACTOR shall promptly remove such materials and goods from the Site.

The cost of supplying all such samples and of conveying same to such place of inspection or testing as the ENGINEER may designate within the country of origin shall be deemed to be included in the tendered rates and prices.

Samples will be retained by the ENGINEER and when directed by the ENGINEER'S REPRESENTATIVE the CONTRACTOR shall dispose of the samples. Except for those which may be incorporated into the works after approval, such as plumbing and electric fixtures.

14) TESTS GENERALLY, ACCESS TO PREMISES

The ENGINEER may examine and may require to be tested any materials or goods required in or for the WORKS such as he may decide from time to time and shall have unrestricted access to the CONTRACTOR'S, Sub-CONTRACTOR's and supplier's premises for such purpose at all times and the CONTRACTOR shall specify this requirement when placing all orders.

The ENGINEER will notify the CONTRACTOR whether materials and goods will be inspected at the manufacturer's or supplier's premises or at the Site. No materials or goods shall be dispatched from such premises until such notification is given and, if appropriate, inspection is complete and a release certificate is given to this effect. In both cases the CONTRACTOR is to notify the ENGINEER when materials and good will be ready for inspection and shall do so adequately in advance for him to make the necessary arrangement for inspection.

The CONTRACTOR shall afford the ENGINEER all facilities, assistance, labour and appliances necessary for the convenient examination, testing weighing or analysis of all such materials or goods. The CONTRACTOR shall provide and prepare such test pieces of any such materials or goods as the ENGINEER may require.

Notwithstanding any tests which may have been carried out off the Site the ENGINEER shall be empowered to order further tests of any materials or goods to be made on the Site and to reject such materials or goods should they fail to pass such test on the site.

The full cost of providing all facilities, labor, consumable stores and appliances required in connection with all testing on the Site shall be deemed to be included in the tendered rates and prices.

15) TEST CERTIFICATES

Should the ENGINEER not inspect any materials or goods at the place of manufacture, the CONTRACTOR shall, if required, obtain certificates of test from the suppliers of such materials or goods and shall send such certificates to the ENGINEER. Such certificates shall certify that the materials or goods concerned have been tested in accordance with the requirements of the Technical Specifications and shall show the results of all the tests carried out. The CONTRACTOR shall provide adequate means of identifying the materials & goods delivered to the Site with the corresponding certificates.

16) TESTING AT AN INDEPENDENT LABORATORY

Where tests are specified or directed by the ENGINEER to be carried out in an independent testing laboratory, the CONTRACTOR shall supply and deliver the samples and shall arrange for the relevant tests to be carried out. The independent testing laboratory shall be nominated by the CONTRACTOR and acceptable to the ENGINEER. Unless otherwise specified the CONTRACTOR shall arrange for one copy each of the independent testing laboratory's test certificates to be delivered to the ENGINEER and to the ENGINEER not less than 3 working days before the materials covered by the relevant test certificates are to be incorporated in the WORKS. Each test certificate shall be relatable to the materials from which the sample was taken.

17) SITE TESTING

The CONTRACTOR shall carry out such laboratory and field test (including tests to check the accuracy of testing equipment and methods but excluding tests specified to be carried out in an independent testing laboratory) as specified or as can reasonably be inferred from herein, as may be necessary to ensure and satisfy the ENGINEER that the requirements of the Technical Specifications are met. The type and frequency of testing shall be in accordance with the relevant standards except as otherwise specified herein or directed by the ENGINEER.

The CONTRACTOR'S attention is drawn to the fact that the frequencies of testing specified in the relevant clauses are intended to represent only a general guide. The ENGINEER shall be empowered to vary the frequencies at which tests are conducted should he deem this necessary for the proper control of the quality of the WORKS. Should the ENGINEER'S REPRESENTATIVE vary the frequencies stated in the relevant clauses of the Technical Specifications, the CONTRACTOR shall not be entitled to extra payments thereof.

Unless otherwise agreed or directed by the ENGINEER methods of sampling and test procedures shall be in accordance with the relevant Standard Methods of ASTM, British Standard Codes of Practice or any other relevant standard approved by the ENGINEERS. Sample will be selected by the ENGINEER'S REPRESENTATIVE.

The CONTRACTOR shall keep clear, accurate and up-to-date records of tests and immediately any test is completed shall supply two copies and summaries of the results thereof to the ENGINEER'S REPRESENTATIVE in such form as he may require. Testing equipment operations and records shall be available for inspection by the ENGINEER'S REPRESENTATIVE at all times.

18) REMOVAL OF CONDEMNED MATERIALS

The ENGINEER'S REPRESENTATIVE may require the CONTRACTOR to remove and dispose of any materials employed of the ENGINEER'S REPRESENTATIVE, are unsuitable or have been incorrectly deposited or have suffered damage by exposure to the weather or otherwise are not in accordance with the specified requirements for such materials. The CONTRACTOR shall be entitled to no payment whatsoever in respect of such materials.

19) SITE OFFICE FOR THE CONTRACTOR

The CONTRACTOR shall provide, erect and maintain in good repair, service and light a substantial weatherproof temporary site office for his site office.

When instructed by the ENGINEER, the CONTRACTOR shall remove and dispose of the building, fittings and floor and make good any damage to the site and leave it clean and tidy.

20) SITE OFFICE AND FURNITURE, EQUIPMENT FOR ENGINEER'S REPRESENTATIVE

The CONTRACTOR shall provide, install, maintain in good repair and on completion take away all at for the direction of the ENGINEER'S REPRESENTATIVE, the site offices as mentioned in the Sub-Contract Agreement (SC-07 and Annex. 10 Tender Documents Volume I), the furniture, equipment and fittings for the site office of the ENGINEER'S REPRESENTATIVE as desired by the ENGINEER.

The foregoing furniture, equipment and miscellaneous items shall be provided and installed by the CONTRACTOR within 15 days of the Letter of Intent from the ENGINEER.

21) SANITARY ACCOMMODATION FOR SITE

The CONTRACTOR shall also maintain and service a suitable sanitary accommodation facility and provide consumable stores including soap, etc.

22) SURVEYING EQUIPMENT

The CONTRACTOR shall provide & maintain in an accurate and serviceable condition the following new surveying equipment at Site at all times during the execution of the Works:

- 1 No. theodolite to read to 20 seconds complete with tripod and accessories.
- 1 No. reversible level complete with tripod and accessories.
- 1 No. 14 ft. telescopic leveling staff graduated in feet.
- 1 No. 100 ft. steel tapes.
- 1 No. 50 ft. steel tapes.
- 1 No. 12 Ft. flexible steel tapes.
- 1 No. Steel tape repair kit.
- 2 Nos. Plumb bobs.

The foregoing equipment shall be inspected at the Site of Works by the ENGINEER'S REPRESENTATIVE within 15 days of the receipt by the CONTRACTOR of the Letter of Intent from the ENGINEER.

In addition to the specified list of equipment, the CONTRACTOR shall also provide and renew from time to time such miscellaneous materials and equipment as might reasonably be required at the Site.

23) TRAFFIC ROUTES TO BE MAINTAINED

- 23.1 The CONTRACTOR shall not cause unnecessary obstruction of roads, footpaths or waterway at any time during the course of the WORKS and in no circumstances shall closure, in whole or in part, of these or any other "right of way" be permitted except with the prior permission of the ENGINEER'S REPRESENTATIVE in writing and the concurrence of the ENGINEER. All disturbances are to be negotiated with the affected community in advance.

The CONTRACTOR shall maintain adequate, through safe traffic routes for vehicles and pedestrians on public highways within and adjacent to the Site of the WORKS,

including such diversions of highways as may be required, and make arrangement for watching, signaling, and control of traffic by day and night and for adequate lighting all to the satisfaction of the ENGINEER'S REPRESENTATIVE.

All temporary diversions shall be constructed to adequate widths and maintained in good condition at all time by the CONTRACTOR to the satisfaction of the ENGINEER'S REPRESENTATIVE and on completion of the CONTRACT all such road shall be left in a condition approved by the ENGINEER. The temporary diversions shall be removed and reinstated to the satisfaction of the ENGINEER/ENGINEER when no longer required.

The CONTRACTOR shall make arrangements and co- operate with all other SUB-CONTRACTORS working in the area for directing, routing, marshalling, controlling and circulating the traffic connected with the WORKS in accordance with the ENGINEER'S REPRESENTATIVE requirements in order that the flow of all traffic may be facilitated, that all obstruction, inconvenience & delay may be minimized and that the interest of all concerned including the general public may be promoted.

The CONTRACTOR shall, before commencing work affect any public highway or right of way, submit to the ENGINEER'S REPRESENTATIVE his proposals for the control of traffic, access for residents & diversions in respect of the area in which he proposes to work. The ENGINEER'S REPRESENTATIVE will consult with the ENGINEER before giving his consent and will require the CONTRACTOR to make such amendments as are considered necessary.

The CONTRACTOR shall pay all cost and expenses, attendant upon the employment of any Police, which the Local Magistrate/Government may appoint for the preservation of peace, or the prevention of trespass and theft, or for any other purpose on or near the site of the WORKS.

24) PROTECTION OF LIVESTOCK

The CONTRACTOR shall be responsible for protection of livestock against damage or accidents because of the WORKS, during day and night. All gaps made in fences and hedges etc. to be closed when WORKS are not in progress and all trenches and excavations to be suitably protected.

25) HAULAGE ROUTES

The CONTRACTOR shall submit to the ENGINEER'S REPRESENTATIVE as soon as possible after the acceptance of the Tender and from time to time thereafter as required, proposals for the routing of traffic in connection with the execution of WORKS being the traffic of the CONTRACTOR, his CONTRACTORS and suppliers in the movement or haulage of heavy loads, construction plant, materials and spoil

(hereinafter referred to as "the construction traffic") including particulars of the public roads of the public roads which he, the CONTRACTOR, proposes to select as routes to be used by the construction traffic.

The ENGINEER'S REPRESENTATIVE will consult the ENGINEER and comment on all such proposal as may be submitted by the CONTRACTOR.

26) SUPPORT

The CONTRACTOR shall provide ample shoring to all poles, buildings, walls, roads, railings and structures etc., adjacent to the trenches and shall carry out the trench work in close-timbered lengths near such property at his own expense.

27) PROTECTION MAINS, SERVICES & APPARATUS

The information given on the Drawings relating to existing services is given for general guidance only and is not guaranteed and no responsibility & Apparatus whatsoever is accepted by the ENGINEER or the ENGINEER for the accuracy thereof. The SUB-CONTRACTOR shall refer directly to the concerned authorities for more detailed information on any of the services within the working spaces of the site.

The CONTRACTOR shall not cause or permit interference with mains, services or apparatus whether indicated on the Drawings or not & shall be responsible for their protection. He shall give notice and provide reasonable facilities in accordance with Clause 3.31 of the CONDITIONS OF CONTRACT to the owners and/or their servants to enable them to do alterations, repairs or maintenance works if so required.

If during the course of the WORKS underground services are uncovered they shall be carefully protected and shall be immediately referred to the ENGINEER'S REPRESENTATIVE.

28) DIVERSION OF MAINS, SERVICES & APPARATUS

The CONTRACTOR shall make arrangements with the appropriate owners/authorities and pay all costs for any temporary diversions of mains, services and apparatus which may be required in carrying out the WORKS.

29) DEALING WITH WATER

The CONTRACTOR shall take all necessary measures to prevent water from the Site causing a nuisance on or in any neighboring land or property either by causing flooding or by depositing sediment on the surface of the ground or in drains or water-courses. Wherever necessary to prevent this, the CONTRACTOR shall construct temporary drainage channels, layers, sumps and traps in addition to those shown on the

Drawings discharging into existing drains, ditches or water-courses. The SUB-CONTRACTOR shall remove all sediment which may accumulate on any land or in any drains, ditches or water-courses or in any other property as a result of his operations.

All WORKS including those below subsoil standing water level shall be carried out in the dry unless specified otherwise. The CONTRACTOR'S arrangements for controlling the inflow of water into the parts of the excavation being worked and during the placing of concrete and other WORKS therein and for the collection and disposal of water shall be to the ENGINEER'S approval.

Water flowing into excavations shall be carried by trenches, drainage layers or open jointed drains to sumps from which it shall be pumped. Such trenches, drains or sumps shall generally be clear of the Works unless approved otherwise by the ENGINEER'S REPRESENTATIVE.

The CONTRACTOR shall keep all surfaces upon or against which concrete is to be deposited free from running water and no concrete shall be placed until such surfaces are properly drained. Suitable precautions shall be taken to prevent running water from washing out cement or concrete while it is setting or from injuring the WORKS in any other way.

Notwithstanding the approval by the ENGINEER'S REPRESENTATIVE of the CONTRACTOR'S methods of dealing with water, the CONTRACTOR shall be responsible for and accept all the risks and liabilities of dealing with water from whatever source and of all effects thereof.

30) WORKS TO BE WATER-TIGHT

All WORKS, intended to retain or exclude water or through which water is to be passed shall be absolute water-tight, so as not only entirely to prevent loss of water from the WORKS, but also so as entirely to prevent the percolation of water into any part or parts of the WORKS.

31) NAME BOARDS / TEMPORARY SIGNAGE

The CONTRACTOR shall erect only such name boards as the ENGINEER may approve as per instructions by UNDP. These must be of simple and becoming appearance. They shall display the name of the project, the CONTRACTOR, the main sub-SUB- Contractors, if any and duly approved by the ENGINEER, and such other information as the ENGINEER may direct or approve.

1. SITE CLEARANCE, CARRIAGE AND LOADING, UNLOADING

1.1. SCOPE

The clearing and grubbing shall consist of clearing the designated area of all trees, down timber, snags, bush, other vegetation, rubbish and all other material, and shall include grubbing stumps, roots, and matted roots, and disposal of all spoil material resulting from the clearing and grubbing. It shall also include the removal and disposal of structures that protrude, encroach upon, or otherwise obstruct the work, except when otherwise provided for on the plans or directed by the Engineer to be saved.

The carriage and stacking of materials shall be done as provided in the Contract Agreement. All tools and plants and means of transport shall be arranged by the SUB-Contractor. The carriage of materials includes loading unloading and stacking unless specifically provided otherwise in the Contract Agreement.

Scope of work shall include the loading into trucks from specified sites or stockpiles (or unloading as the case may be) as provided in the Contract Agreement and approved by the Engineer.

1.2. EXECUTION

1.2.1. LOCATION OF WORKS

The Engineer will define the limit of areas where clearing and grubbing is to be done. Normally it will include all land within the right of way and all other construction area including ditches, detours, minor road crossings and other areas shown on the plans or as specified or as directed by the Engineer. The Engineer will designate the fences, structures, debris, trees and bushes to be cleared where grubbing is not required. It shall not include clearing and grubbing of borrow or other pit areas from which material is secured. It shall include the leveling or removal of all bunds or mounds within the right of way unless otherwise directed by the Engineer.

All roots and stumps within the limits of the Site shall be grubbed and excavated unless otherwise specified or approved by the Engineer. Unless otherwise directed, holes from grubbing up trees, bushes and other holes from which obstructions are removed, shall be filled with suitable material and compacted in an approved manner.

1.2.2. DISPOSAL

The CONTRACTOR shall be responsible for disposal of any un-wanted material not to remain on Site within fourteen (14) days after cutting or felling unless otherwise approved. No tree trunks, stumps or other debris shall be left within Site unless approved in writing by the Engineer. The location of disposal areas shall be within or

outside the limits of the project or as approved in writing by the Engineer and shall be acquired by the CONTRACTOR at his own expense. Any useable material shall remain the property of the ENGINEER, and shall be stockpiled or stored safely by the SUB-Contractor. CONTRACTOR shall be responsible for obtaining permission from local authorities if & when required for disposal.

1.2.3. BURNING

There shall be no burning on or around the Site area whatever. The CONTRACTOR shall ensure that neither his Employees nor anyone whosoever burns anything on or within specified limits around the Site area.

1.2.4. PROTECTION AND RESTORATION

The CONTRACTOR shall prevent all damage to pipes, conduits, wires, cables or structures above or below ground. No land monuments, property markers, or official datum points shall be damaged or removed until the Engineer has witnessed or otherwise referred their location and approved their removal. The CONTRACTOR shall so control his operations as to prevent damage to trees and shrubs, which are to be preserved. Protection may include fences and boards lashed to trees to prevent damage from machine operations. The existing covered or open benchmarks should be relocated as directed by the Engineer. In the event that anything specified herein to be saved and protected is damaged by the CONTRACTOR; such damages shall immediately be repaired or replaced by the CONTRACTOR at his own cost to the satisfaction of the Engineer. All areas cleared and grubbed must be approved by the Engineer or Engineer's Representative before the start of cleaning operations.

The CONTRACTOR undertaking carriage of material shall be responsible for its safe loading, carriage, unloading, and delivery to the specified site within the specified time and stacking.

Depending upon the feasibility and economy, the CONTRACTOR shall propose the mode of carriage viz. whether by mechanical or animal transport and shall be as approved by the Engineer in accordance with corresponding item as provided in Contract Agreement.

1.2.5. REQUIREMENTS

1.2.5.1 The CONTRACTOR shall furnish, install, operate and maintain all necessary facilities for loading/unloading trucks.

1.2.5.2 The CONTRACTOR shall perform all loading/unloading operations in a systematic manner without breakages or segregation as determined by the Engineer. The CONTRACTOR shall load trucks in which materials are to be transported in such a

manner as to avoid loss in transit and shall be responsible for and make good any loss of materials lost in transit due to improper loading of mobile trucks and other handling operations. The materials carted shall be properly stacked as specified or directed by the Engineer.

2. DISMANTLING WORKS

2.1 SCOPE

The work covered by this section of the specifications pertains to the demolition and dismantling of the existing retaining walls and existing buildings. Foot prints of old buildings, Floors and stone masonry walls below plinth level and consists of furnishing all plant, labor, tools, equipment, appliances and performing all operations as required herein drawings and / or as directed by the Engineer at the proposed site.

2.2 EXECUTION AND MEASURES

The Demolition and Dismantling work of existing structures shall not proceed until the CONTRACTOR makes submittals and gets approved by the Engineer, the methodology of demolition and dismantling works and drawings of temporary shoring / lateral soil retaining system. Shoring shall be such as to protect workmen, adjacent paving, structures and utilities.

Demolitions and dismantling shall be performed in an orderly manner and the SUB-Contractor shall take all necessary precautions and expedients to prevent damages to the adjacent structures otherwise he will be responsible for the damages. Any existing utility lines which are not known to the CONTRACTOR in sufficient time to avoid damage, if inadvertently damaged during demolition, shall be repaired by the Contractor and adjustment in payment will be made as approved by the Engineer.

Explosives shall be used only to blast / excavate bedrock from the site and for no other work. The contractor is required to make a detailed submittal regarding rock blasting / excavation for review and approval by Engineer.

Seismic monitoring during blasting shall be done by the CONTRACTOR to avoid damage to adjoining and other nearby structures. A Pre-construction survey of adjoining structures must be carried out to evaluate their existing condition in order to protect the structures and disputes arising there from.

Where approval has been given to the CONTRACTOR for carrying out demolition operations at night or in places where day light is excluded, the CONTRACTOR shall provide adequate lighting at all points of demolition and transportation.

3. EARTHWORK

3.1. SCOPE

The work under this section of the specification consists of furnishing all plant, labor, equipment, appliances and materials and in performing all operations in connection with earthwork of all underground services and structural units, roads and temporary drainage, 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.

3.2. SUBMITTALS

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

- a. Record of existing Site levels
- b. Record of levels after completion of Site leveling and stripping
- c. Record of existing trees

3.3. EXECUTION

The CONTRACTOR shall be deemed to have made local and independent inquiries 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.

All excavations, cuts and fills shall be constructed to the lines, levels, slopes and gradients specified with any necessary allowance for consolidation, settlement and drainage so that at the end of the Defects Liability Period the ground shall be at the required lines, levels and gradients. During the course of the Contract and during the Defects Liability Period any damage or defects in cuts and fills, in structures and other works or rolling of stones/boulders caused by blasting or otherwise, 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.

3.3.1. EXCAVATION SUPPORT

- 33.1.1. Prior to Commencing any structural excavation work which is 5 feet or greater in depth the CONTRACTOR shall design an excavation support system.
- 33.1.2. Details of the excavation support system shall be submitted to the Engineer for review and approval at least one week before any excavation work commence. Details of the excavation support system shall be complete with, but not limited to the following:-
- a. Drawings of the structural support members showing materials, sizes and spacing
 - b. Calculations showing the maximum theoretical deflection of the support member.
- 33.1.3. The CONTRACTOR shall make a detailed inspection of all adjoining structures and prepare a report on the pre-construction condition of all structures that may be affected during construction of the Works. The report will include photographs, drawings and sketches with levels and dimensions fully illustration the structure's condition. In particular, it shall note any existing damage or structural inadequacy. Deficiencies and damage are to suitably mark on the structure in a way that is not permanently defaced. This report shall be submitting along with excavation support system.
- 33.1.4. The system is to be designed so that no members extend through surfaces exposed in the finished construction, and no shoring or bracing is placed under permanent structures.
- 33.1.5. The CONTRACTOR shall submit to the engineer calculations of lateral earth pressure for the full excavation depths, surcharge loads of any description, equipment loads, and forces at various stages of support during excavation, the maximum design loads to be carried by various members of the support system and strut pre-load forces.
- 33.1.6. If the structure support system proposed includes tieback anchors, the CONTRACTOR's submitted details shall include drawings that show the profile of the soil in which each anchor is to be installed.

3.3.2. SITE PREPARATION

- 33.2.1. The CONTRACTOR shall set out the work 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 work, the CONTRACTOR shall at his own expense rectify such error, to the satisfaction of the Engineer/Engineer's Representative.

- 3.3.2.2. The CONTRACTOR shall construct and maintain accurate bench marks so that the Lines and Levels can be easily checked by the Engineer/Engineer's representative throughout the construction period.

3.4. EXCAVATIONS

- 3.4.1. Excavation shall include the removal of all material of every name and nature.
- 3.4.2. The major portion of excavations shall be carried out by mechanical excavators and excavated materials disposed off to stock on spoil as directed by the Engineer. The excavation may be done by normal means. 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 limits of whole of the Project Site at locations designated and approved by the Engineer.
- 3.4.3. Excavated material unsuitable for use as fill and backfill shall be disposed off by the CONTRACTOR at locations designated and approved by the Engineer outside the Project Site. CONTRACTOR shall be responsible for obtaining permission from local authorities if & when required for disposal.
- 3.4.4. The CONTRACTOR shall give reasonable notice that he intends to commence any excavation and shall submit to the Engineer full details of his proposals. The Engineer's approval shall not relieve the CONTRACTOR of his responsibility with respect to such work.
- 3.4.5. 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. SUB-Contractor will install / fix safety barrier around the excavated pits and ditches to avoid any accident.
- 3.4.6. All excavations shall be kept free of water and shall be maintained dry to the satisfaction of the Engineer. Prevent surface water and sub-surface water from flowing into the excavation and flooding the project site and surroundings.
- 3.4.7. The CONTRACTOR shall not allow water to accumulate in excavations and shall remove water from excavations to prevent softening of foundation bottoms, under cutting footings and soil changes detrimental to the stability of sub-grades

and foundations. Provide discharge lines necessary to convey the water away from the excavations. Convey water, removed from excavation and rain water, to outside the limits in manner that no damages are caused to the surrounding services properties.

- 3.4.8. In blasting rock slopes, reasonably uniform faces shall be left, regardless of whether or not the excavation is carried beyond the specified slope. Any over breakage below the depth will not be paid for.
- 3.4.9. Excavation for pits, cable trenches, equipment-foundations and other structures shall be taken out to the levels and dimensions shown on Drawings or such other levels and dimensions as the Engineer may direct.
- 3.4.10. 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. The additional excavation for placing and removal of forms, installation of services, for inspection and generally for working area on slopes for stability shall not be measured for payment and shall be deemed to be included in the rates for excavation as measured net.
- 3.4.11. 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.
- 3.4.12. No excavation shall be refilled nor any permanent work commenced until the foundation has been inspected by the Engineer and his permission to proceed is given.
- 3.4.13. If excavation for sub-structures is 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 SUB-Contractor.
- 3.4.14. The placing of blinding concrete, placing of reinforcement and casting of the permanent works in the excavation shall be carried out in the dry condition.
- 3.4.15. 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 SUB-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.

- 3.4.16. 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 re-done by the CONTRACTOR at his own cost. Any existing utility lines which are not known to the CONTRACTOR in sufficient time to avoid damage, if inadvertently damaged during excavation, shall be re-done by the CONTRACTOR at this own cost 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.
- 3.4.17. Before starting the excavation for pipelines, the CONTRACTOR shall ensure the correct alignment of the pipeline 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.
- 3.4.18. Excavation shall be carried out true to lines, levels, grades and widths as shown on the drawings or as directed by the Engineer ensuring proper laying of the pipe line, the bedding fill, construction of chambers for appurtenances and any other structures. The trench bottom shall be graded to provide even and substantial bearing over the specified bedding and of the structure.
- 3.4.19. Without the written permission of the Engineer, not more than 600 feet of the trench shall be opened in advance of the completed pipeline.
- 3.4.20. The Engineer may require the CONTRACTOR to excavate below the elevations shown on the drawings or may order him to stop above the elevations shown depending upon the suitable foundation material encountered.
- 3.4.21. If for any reason, the levels, grades or profiles of the excavations are changed adversely by the CONTRACTOR, 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.

3.5. BARRICADES, WARNING LIGHTS, SIGNS

All excavations made hereunder shall be properly maintained while they are open and exposed. Sufficient suitable barricades, warning lights, signs and similar items shall be provided by the CONTRACTOR. The CONTRACTOR shall be responsible for any personnel injury or property damage due to his negligence.

3.6. QUALITY ASSURANCE (EXCAVATION)

All slopes, lines and grades shall be true, correct and accurate to those shown in the plans or otherwise directed and approved by the Engineer. The sub-grade in cuts shall be accurate to the authorized profile grade for the sub-grade to + one inch (1"). Where discrepancies are found in the work the CONTRACTOR shall make the necessary corrections.

3.7. SAFETY MEASURES

Special measures shall be taken to handle dust / dirt control. During construction phase the ENGINEER may order, in writing, any or all shoring, sheeting and piling to be left in place for safety reasons, whether such sheeting was shown on drawings or not. If left in place, such sheeting shall be cut-off at the elevation approved by the ENGINEER, and shall be driven tight and its cost shall be considered included in the tendered rates.

3.8. FILL AND BACKFILL

- 3.8.1. The backfilling shall include filling under the floors, around the foundation trenches, pipes, conduits, ducts and channels.
- 3.8.2. The backfilling shall include loading, unloading, transporting, placing, stacking, spreading of earth, watering, rolling, ramming and compacting, etc., complete as specified herein.
- 3.8.3. Backfill shall be either using granular backfill material or common backfill as directed and approved by the Engineer. Granular backfill materials shall meet the following requirements.

Grading Requirements

Mm	Inch	A	B
25	1"	100	100
19	3/4"	60 – 100	75 – 100
4.75	No. 4	50 – 85	55 – 100
2.0	No. 10	40 – 70	40 – 100
0.425	No. 40	25 – 45	20 – 50
0.075	No. 200	0 – 15	5 – 15

- 3.8.4. Material satisfying the requirements of coarse sand falling under soil classification A-3 (AASHTO). In case coarse sand is utilized for granular fill it shall be ensured that the same is confined properly with approved material.
- 3.8.5. The material shall have a plasticity index of not more than six (6) as determined by AASHTO T – 89 and T – 90.
- 3.8.6. The excavated material if found suitable shall be stockpiled within the free haulage limit of the Project Boundary. This material shall be used for filling/back-filling if approved by the Engineer and shall be transported by the SUB-Contractor anywhere required for the purpose of filling/back-filling work in this Contract.
- 3.8.7. The CONTRACTOR shall provide the approved quality of backfill and fill material required to complete the fill and back- filling work from the places as designated by the Engineer.
- 3.8.8. Deep filling shall be predominantly granular material and free from slurry mud, organic or other unsuitable material and capable of compaction by ordinary means.
- 3.8.9. Material for backfilling shall be as approved by the Engineer and shall be placed in layers not exceeding six (06) inches measured as compacted material with optimum water and compacted to produce in-situ density shall not be less than 95% of the maximum dry density at optimum moisture content.
- 3.8.10. Depending on the depth of fill the Engineer may instruct increased thickness of successive layers to be placed.
- 3.8.11. The filling shall be compacted by mechanical means as approved by the Engineer.
- 3.8.12. Filling around pipes and cables shall be carefully placed with fine material to cover the pipe or cable completely before the normal fill is placed.
- 3.8.13. Backfilling of trenches/foundations shall be carried out only after the pipe line/structural works within the excavations have been inspected, tested and approved by the Engineer.
- 3.8.14. 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.

3.8.15. Before the start of fill and backfill, the CONTRACTOR shall satisfy himself as to the levels and slopes of the fills and backfill shown on the Drawings, the requirements of compaction, the possibility of settlement & all other particulars whatsoever in connection with the filling works.

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

3.9. QUALITY ASSURANCE (BACKFILLING)

The stabilization of compacted backfill/fill surface shall be smooth and even and shall not vary more than 3/8 inch in 10 feet from true profile and shall not be more than 1/2 inch from true elevation.

3.10. DISPOSAL OF SURPLUS EXCAVATED MATERIAL

3.10.1. The rejected unsuitable material and surplus excavated material shall be disposed off outside the site and/ or as directed by the Engineer. No compensation of any lead/lift is admissible. The surplus excavated material shall be so placed that it will present a neat appearance and not offer any danger to abutting properties.

3.10.2. The material shall be declared unsuitable if the soaked CBR (96 hours) is less than five (5) percent or if falls under A-6 or A-7 of AASHTO soil classification.

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

3.11. WATERING FOR DUST CONTROL

3.11.1 Provide an adequate water supply and apply water needed at all hours (including nights, weekends, and periods of non-work) as necessary to control dust. Uniformly apply water using pressure-type distributors, pipelines equipped with spray systems, or hoses with nozzles.

3.11.2 Project dust control for public benefit. Control dust within the construction limits at all hours when the project is open to public traffic. When the project is not open to public traffic, control dust in areas of the project which neighbor inhabited residences or places of business. Control dust on approved, active detours established for the project. Apply water at the locations, rates, and frequencies ordered by the Engineer In-charge.

- 3.11.3 Control dust on active haul roads, in pits and staging areas, and on the project during all periods not covered in above.
- 3.11.4 The dust control must be completely in accordance with the approved EMMP Report as attached in the Tender Documents Volume-I "Exhibit M".

4. TERMITE CONTROL TREATMENT

4.1. 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 insecticide used for anti-termite treatment should be from the approved list given. The scope also covers treatment of all wood works with insecticides before installation in position.

4.2. APPLICABLE STANDARDS

All methods of termite protection used herein shall be in accordance with the standard practices as per manufacturers guide lines / recommendations. The anti-termite treatment should be executed in accordance with the approved EMMP Report.

4.3. SUBMITTALS

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.

4.4. QUALITY ASSURANCE

In addition to the requirements of these specifications, comply with manufacturer's instructions and recommendations for the work, including preparation of substrata and application. A professional operator shall be engaged who shall have license in accordance with regulations of governing environmental authorities for application of soil treatment solution.

4.5. DELIVERY AND STORAGE

Store in closed original containers, in a cool, well ventilated area away from human being, food and feed stuffs. Do not store for prolonged periods in direct sunlight. In case of spillage, confine and absorb spilled product with absorbent material such as sand, clay or cat litter. Material should be stored at site as per manufacturer's instructions. Do NOT allow spilled product to enter sewers, drains, creeks or any other waterways.

4.6. PROJECT CONDITIONS

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 sidewalks and paving abutting buildings for distance of at least 6 feet beyond building line. Solution shall be applied in amounts of not less than 5 lit./ Sq.M or 5 lit./10.76

Sq.ft. of area. If applied over gravel or sand fill, application shall not be less than 7 lit./ Sq.M or 7 lit./10.76 Sq.ft. of area. Insecticide shall penetrate to a depth of 1-inch minimum in porous earth at bottom and 2 inch to 3 inch at sides of excavations.

4.7. MATERIAL/PRODUCT

An emulsible concentrate insecticide shall be used for dilution with water, specially formulated to prevent infestation by termites. Fuel oil will not be permitted as a diluent. Provide a working solution of the following chemical elements and concentrations:

- **AGENDA 25 EC** Containing FIPRONIL
- **MIRAGE 5% SC** IMIDACLOPRID

All mixing shall be done at site and mixing proportion of insecticide with water shall be in accordance with the approved manufacturer's recommendations and shall be verified by the Engineer. The insecticide used for anti-termite treatment should be from the approved list. Pure turpentine shall be used for dilution of insecticide, in approved proportion for application to woodwork.

4.8. EXECUTION /APPLICATION

- 4.8.1 Insecticide solution shall be applied with approved pressure spraying equipment maintaining a pressure of 150 psi to all applications to, on or in earth. 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 or concrete should be applied over soil treatment until at least 24 hours after treatment has been made.
- 4.8.2 Sides of foundation excavations, grade beam, and similar areas shall be treated with solution at a rate of 0.5 lit per square feet upon inner sides of such excavations, and at all locations where concrete slabs for platforms and similar work about 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.
- 4.8.3 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. 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.
- 4.8.4 All woodwork 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. before installation. 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.

4.9. GUARANTEE

- 4.9.1 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.
- 4.9.2 In the event of any damage caused within the guaranteed period, the SUB-Contractor shall replace at his own cost such damaged material and finishes affected and suitably preserve and treat the entire premises with the best method known to the trade to prevent the spreading of termites.

5. FORMWORK

5.1. SCOPE

This section of the Specification covers formwork and false work including removal and disposal thereof, for concrete work.

5.2. DEFINITIONS

"Formwork" means the surface against which concrete is placed to form a face, together with all the immediate supports to retain it in position while concrete is placed.

"False work" means the structural elements supporting both the formwork and the concrete until the concrete becomes self-supporting.

A "formed face" is one which has been cast against formwork.

An "exposed face" is one which will remain visible when construction has been completed.

5.3. SUBMITTALS

Before construction begins, submit to the Engineer drawings showing details of the proposed formwork and false-work if so required by the Engineer.

5.4. CONSTRUCTION OF FORMWORK AND FALSE WORK

5.4.1. Construct formwork and false work such that they will support the loads imposed on them by the fresh concrete together with additional stresses imposed by vibrating equipment and by construction traffic, so that after the concrete has hardened the formed faces shall be in the positions shown on the drawings within the tolerances set out hereinafter. No wooden props are allowed to be placed under formwork. Only steel pipes are permitted.

5.4.2. Properly found ground supports on footings designed to prevent settlement. Do not found supports on frozen ground unless the Engineer has agreed to it.

5.4.3. Unless otherwise specified, evenly space horizontal and vertical joints in formwork for exposed faces; joints shall be continuous or form a regular pattern as approved by Engineer.

- 5.4.4. Make all joints, in formwork including formwork for construction joints, tight against the escape of cement and fines. Where reinforcement projects through formwork, fit the form closely around the bars.
- 5.4.5. Design the formwork so that it may be easily removed from the work without damage to the faces of the concrete. Also incorporate provisions for making minor adjustments in position, if required, to ensure the correct location of concrete faces. Make due allowance in the position of all formwork for movement and settlement under the weight of fresh concrete.
- 5.4.6. Where overhangs in formwork occur, provide means to permit the escape of air and ensure that the space is filled completely with fully compacted concrete.
- 5.4.7. Provide formwork on both faces for concrete surfaces at slopes of 30 to the horizontal or steeper. Surface at slopes less than 20 may be formed by screeding. Surface at slopes between 20 and 30 shall generally be formed unless the SUB-Contractor can demonstrate to the satisfaction of the Engineer that such slopes can be screeded with the use of special screed boards to hold the concrete in place during vibration.
- 5.4.8. Adequately secure horizontal or inclined formwork, to the upper surface of concrete, against uplift due to the pressure of fresh concrete. Also tie down formwork to voids within the body of the concrete or otherwise secure against floating.
- 5.4.9. At the internal and external angles on concrete surfaces, provide forms with fillets and chamfers of the sizes shown on the drawings or of 20mm x 20mm if not shown on drawings.
- 5.4.10. Supports for formwork may be bolted to previously placed concrete provided the type of bolt used is acceptable to the Engineer. If metal ties through the concrete are used in conjunction with bolts, do not leave the metal closer than 50mm to the face of the concrete.
- 5.4.11. Do not re-use formwork after it has suffered damage which is sufficient to impair the finished surfaces of the concrete.
- 5.4.12. Where circumstances prevent easy access within the form for cleaning and inspection, provide temporary openings for this purpose through the formwork.
- 5.4.13. Provide shear keys in all construction joints of the size and shape indicated on the drawings or as approved by the Engineer.

- 5.4.14. Where precast concrete elements are specified for use as permanent formwork or proposed by the CONTRACTOR and agreed by the Engineer, set such elements true to line and level within the tolerances.

5.5. PREPARATION OF FORMWORK

- 5.5.1. Before any reinforcement is placed into position within formwork, thoroughly clean the formwork and then dress with approved release agent. The agent shall be either suitable oil incorporating a wetting agent, an emulsion of water suspended in oil or low viscosity oil containing chemical agents. 'Do not use an emulsion of oil suspended in water nor any release agent which causes staining or discoloration of the concrete, air holes on the concrete surface, or retards the set of the concrete.
- 5.5.2. In order to avoid color differences on adjacent concrete surface, use only one type of release agent in anyone section of the Works.
- 5.5.3. In case where it is necessary to fix reinforcement before placing formwork, carry out all surface preparation of formwork before it is placed into position. Do not allow reinforcement or prestressing tendons to be contaminated with formwork release agent.
- 5.5.4. Before placing concrete remove all dirt, construction debris and other foreign matter completely from within the placing area.
- 5.5.5. Before concrete; placing commences, secure all wedges and other adjusting devices against movement during concrete placing and maintain a watch on the formwork during placing to ensure that no movement occurs.

5.6. REMOVAL OF FORMWORK

- 5.6.1. Carefully remove formwork without shock or disturbance to the concrete. Do not remove formwork until the concrete has gained sufficient strength to withstand safely any stresses to which it may thereby be subjected.
- 5.6.2. Allow the minimum periods to elapse between completion of placing concrete and removal of forms as given below, which apply to ambient temperatures higher than 10 C. At lower temperatures or if cement other than ordinary Portland is involved, the Engineer may instruct longer period.

Vertical formwork to columns, wall and beams 48 hours

Soffit formwork to slabs 15 days

Props to slabs	15 days
Soffit formwork to beams	15 days
Props to beams	15 days

Tolerances shall be as considered reasonable by the Engineer.

- 5.6.3. Alternatively, remove formwork when the concrete has attained the desired strength, provided that the attained strength is determined by making test cylinders and curing them under the same conditions as the concrete to which they refer.
- 5.6.4. Compliance with these requirements shall not relieve the CONTRACTOR of his obligation to delay removal of formwork until the removal can be completed without damage to the concrete.
- 5.6.5. If the CONTRACTOR wishes to strip formwork from the underside of arches beams and slabs before the expiry of the period for supports set out above, it shall be designed so that it can be removed without disturbing the supports Do not remove supports temporarily for the purpose of stripping formwork to subsequently replace them.
- 5.6.6. As soon as the formwork has been removed, completely fill bolt holes in concrete faces other than construction joints which are not required for subsequent operations, with mortar sufficiently dry to prevent any slumping at the face. Mix the mortar in the same proportions as the fine aggregate and cement in the surrounding concrete and with the same materials and finish flush with the face of the concrete.

5.7. SURFACE FINISHES FOR FORMED SURFACES

5.7.1 Classes of Finish for Formed Surface:

The surface finish to be achieved on formed concrete surfaces shall be as defined hereunder:

5.7.1.1 Class F1 Finish

This finish is for surfaces against which backfill or further concrete will be placed. Formwork may be sawn boards, sheet metal or any other suitable material which will prevent the loss of fine material from the concrete being placed.

5.7.12 Class F2 Finish

This finish is for surfaces which are permanently exposed to view but where the highest standard of finish is not required. Forms to provide a Class F2 finish shall be faced with wrought thicknesses tongued and grooved boards with square edges arranged in a uniform pattern and close jointed or with suitable sheet material. The thickness of boards or sheets shall be such that there shall be no visible deflection under the pressure exerted by the concrete placed against them. Joints between boards or panels shall be horizontal and vertical unless otherwise directed. This finish shall be such as to require no general filling of surface pitting, but fins, surface discoloration and other minor defects shall be remedied by methods agreed by the Engineer.

5.7.13 Class F3 Finish

This finish is for surfaces which will be in contact with water flowing at high velocity, and for surfaces prominently exposed to view where good appearance is of special importance. To achieve this finish, which shall be free of boards marks, the formwork shall be faced with plywood complying with BS 1088: 1966 with amendments 1 & 2 or equivalent material in large sheets. The sheets shall be arranged in an approved uniform pattern. Wherever possible, joints between sheets shall be arranged to coincide with architectural features or changes in direction of the surface. All joints between panels shall be vertical and horizontal unless otherwise directed. Suitable joints shall be provided between sheets to maintain accurate alignment in the plane of the sheets. Unfaced wrought boarding or standard steel panels will not be permitted for Class F3 finish. Ensure that the surface is protected from rust marks, spillages and stains of all kinds.

5.7.14 Class F4 Finish

This finish is similar to that required for F3 but is used in places where a first class alignment and a dense surface free from air holes and other defects is required, suitable for the application of decorative finishes, in very high velocity water channels and in other similar circumstances.

The CONTRACTOR's attention is drawn to the fact that this finish requires careful selection of materials and the highest quality of workmanship and supervision at all stages.

5.7.2 Curved Surface

For curved surface where F2, F3 or F4 finishes are called for, the formwork face shall be built up of splices cut to make a tight surface which shall then be dressed to produce the required finish.

Alternatively, single curvature surfaces may be faced with plastic or plywood linings attached to the backing with adhesive or with escutcheon pins driven flush. Linings shall not bulge, wrinkle or otherwise deform when subjected to temperature and moisture changes.

5.7.3 Tolerances

All parts of formed concrete surfaces shall be in the position shown on the Drawings within the tolerances set out in Table.

In cases where the Drawings call for tolerances other than those given in Table the Drawings shall rule.

Where precast units have been set to a specified tolerance, make further adjustments as necessary to produce a satisfactory straight or curved line. When the Engineer has approved the alignment, fix the units so that there is no possibility of further movement.

Note-1:

The tolerance A, B and C given in the table are defined as follows:

Class of Finish	Tolerances in mm (See Not 1)		
	A	B	C
F1	10	10	+25 – 10
F2	05	10	+ or – 15
F3	02	05	+ or – 10
F4	Nil	02	+ or - 10

"A" is an abrupt irregularity in the surface due to misaligned formwork or defects in the face of the formwork.

"B" is a gradual deviation from a plane surface as indicated by a straightedge 3 m long. In the case of curved surface the straightedge shall be replaced by a correctly shaped template.

"C" is the amount by which the whole or part of a concrete face is displaced from the correct position shown on the Drawings.

Note-2:

Abrupt irregularities are not permitted in an F4 finish. Any residual irregularities which remain after removal of formwork shall be removed by grinding to achieve a transition of 1 in 50 between the surface adjacent to irregularity.

5.7.4 Remedial work to defective surfaces

If on stripping any formwork the concrete surface is found to be defective in any way, make no attempt to remedy such defects prior to the Engineer's inspection and the receipt of any instructions which the Engineer may give.

Defective surfaces shall not be made good by plastering. Cut back area of honeycombing, which the Engineer agrees may be repaired, to sound concrete or to 75 mm whichever is the greater distance. In the case of reinforced concrete, cut the area back to at least 25 mm clear distance behind the reinforcement or to 75 mm, whichever is the greater distance. The cavity shall have sides at right angles to the face of the concrete. After cleaning out with water and compressed air, apply bonding agent with brush, brush on a thin layer of bonding agent to the concrete surfaces in the cavity and then fill immediately with concrete of the same class as the main body but with aggregate larger than 20mm nominal size removed. Use a form against the cavity, provide with lip to enable concrete to be placed. Fill the form to a point above the top edge of the cavity.

After seven days, break off the lip of concrete, and grind the surface smooth.

Grind down the surface irregularities, which are outside the limits of tolerance set out in sub-clause (c) above, in the manner and to the extent instructed by the Engineer.

Deal with defects, other than those mentioned above, as instructed by the Engineer.

5.8. SURFACE FINISHES FOR UNFORMED SURFACE

5.8.1. Classes of finishes

5.8.1.1. Class U1 (Rough finish)

Pour the concrete to required elevation and top surface screeded true, even and level in both directions with a straight edge, after compacting, using a sawing motion. After the concrete has hardened sufficiently, float the surface by hand or machine to a uniform surface free from screed marks. Then sufficiently roughen floated surface with broom or stiff steel wire brushes. Class U1 finish shall be provided to all surfaces which will subsequently receive further flooring or plastering etc.

5.8.1.2. Class U2 (Smooth Finish)

After the surface has been floated as in Class U1 finish and when the moisture film has disappeared and the concrete has hardened sufficiently to prevent laitance from being worked to the surface, steel trowel the surface under firm pressure to produce a dense, smooth uniform surface free from trowel marks in three operations; firstly to equalize surfaces as an initial finish, then secondly as a semi-final finish and allow to stand until trowel rings under impact with cement surface, and finally burnish with steel trowel to a smooth hard, unblemished surface. In no instance use any dry cement or admixture of any kind (unless approved) during troweling process. Class U2 finish shall be provided where smooth finish is required.

5.8.2. Tolerances for sizes, levels alignment etc.

The CONTRACTOR shall be responsible for setting and maintaining concrete forms sufficiently within the tolerance limits so as to ensure completed work within the tolerances specified herein. Concrete work that exceeds the tolerance limits specified herein shall be remedied or removed and replaced at the expense of and by the CONTRACTOR. The tolerances are not cumulative.

6. REINFORCEMENT

6.1. SCOPE

The work under this section of specifications consists of furnishing, cutting, fabricating, bending and placing steel reinforcement and Welded wire fabric in any floor and at any height in concrete structures or elsewhere as shown on the drawings or as directed by the Engineer.

6.2. APPLICABLE STANDARDS

Latest editions of the following ASTM Standards are relevant to these specifications wherever applicable.

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.
A 185	Welded steel wire fabric for concrete reinforcement.

All reinforcement shall be deformed hot rolled billet steel bars conforming to ASTM A-615M Grade 60 with specified Yield Strength neither less than 60,000 psi nor more than 78,000 psi and ratio of Ultimate Strength to yield Strength not less than 1.25. Bars shall be mild steel deformed bars Grade 40 with a minimum Yield Strength of 40,000 psi where required as per drawings.

6.3. SUBMITTALS

Reinforcement shall be obtained only from manufacturers approved list / Engineer. Each consignment of reinforcement steel shall be accompanied by the manufacturer's certificate or shall refer to a previous certificate, if the consignment is from the same batch, showing that the reinforcement steel complies with the specified requirement. If such certificate is not made available or if the Engineer considers that the manufacturer's tests are inadequate, test samples shall be taken for acceptance test from different consignments as the Engineer may direct and shall be tested at the SUB-Contractor's cost. Should the result of such tests show that the sample does not meet with the specifications the whole consignment shall be rejected and removed from the site at the CONTRACTOR's cost.

Submit (i) samples in triplicate, of each bar dia., from each consignment brought at Site, (ii) samples of binding wire, (iii) test results, and (iv) samples of spacer blocks & steel chairs.

6.4. 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.

All detailing shall be done as per ACI, standards ACI-315 & 318. The CONTRACTOR shall obtain approval of the bar bending schedules before starting actual bar bending works.

6.5. QUALITY ASSURANCE

Get the samples of bars (and wire if required by Engineer) tested at a Laboratory approved by the Engineer, and use in Works only the materials conforming to the Specification.

6.6. MATERIAL AND SIZE OF BARS

Reinforcement for concrete shall conform to the respective ASTM A615M Standards as specified in the Drawings / specified by the Engineer.

Standard weights of reinforcement bars shall be as tabulated below.

Bar Dia.	¼"	3/8"	½"	5/8"	¾"	7/8"	1"	1-¼"
	6mm	10mm	13mm	16mm	19mm	22mm	25mm	32mm
Wt. Lbs per ft	0.167	0.376	0.668	1.043	1.502	2.044	2.670	4.303
Wt. Kg per meter	0.249	0.560	0.994	1.552	2.235	3.041	3.973	6.403
Wt. Kg per rft	0.076	0.1706	0.303	0.473	0.681	0.927	1.211	1.952

6.7. DELIVERY AND STORAGE

6.7.1. 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.

6.7.2. 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, pitting, 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. CONTRACTOR will construct working platform where the cutting, bending process will be done.

6.8. EXECUTION / FABRICATING, BENDING & PLACING

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

The cutting tolerance for all bars shall be + 1 inch.

6.8.2. Where an overall or an internal dimension of a bent bar is specified in the schedule, the bending tolerance, unless otherwise stated, shall be as follows:

- Splice length & Bent length as per drawings

6.8.3. Reinforcement shall not be bent or straightened in a manner that will damage the material.

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

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

6.8.6. Bars which depend for their strength on cold working shall not be heated for any reason.

6.8.7. Welding shall be permitted for bars only under suitable conditions and with suitable safeguards in accordance with BS 693, BS 1856, or AWS D12.1, provided

the type of reinforcing 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. Welding shall be done as in lectum structural steel & metal works.

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

6.8.9. Reinforcement is to be accurately placed as shown in the drawings, and secured against displacement by using 18-20 gauge black annealed 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 & properly cured for a period of Seven days to achieve required strength.

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

6.8.11. Concrete clear cover for reinforcing steel shall be as follows:-

<u>Structural Members</u>	<u>Minimum Cover</u> <u>(inches)</u>
a. Concrete cast against and Permanently exposed to earth	3
b. Concrete exposed to earth or weather:	
For reinforcing bars # 6 or larger	2
For reinforcing bars less than # 6	1-1/2
c. Concrete not exposed to weather or in contact with ground:	
Slabs, Walls	3/4
Beams, Columns (Primary Reinforcement)	1-1/2

6.8.12. Bars shall be placed to the following tolerances:-

- | | | |
|----|---|----------------|
| a. | Concrete cover to formed surfaces | $\pm 1/4$ inch |
| b. | Minimum spacing between bars | - 1/4 inch |
| c. | Top bars in slabs and beams | |
| | i. Members 8 inch deep or less | $\pm 1/4$ inch |
| | ii. Members more than 8 inch but not over 2 feet deep | $\pm 1/2$ inch |
| | iii. Members more than 2 feet deep | ± 1 inch |
| d. | Crosswise of members: spaced evenly within | 2 inch |
| e. | Lengthwise of members | ± 2 inch |

6.8.13. 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.

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

6.8.15. 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.

6.8.16. All reinforcement, at the time concrete is placed, shall be free of loose mill scale, loose rust mud, oil grease, or other materials that may adversely affect or reduce the bond.

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

7. PLAIN AND REINFORCED CONCRETE

7.1. SCOPE

The work under this section of the specification consists of furnishing all plant, labor, equipment, appliances and materials and in performing all operations in connection with the supply and installation of plain and reinforced concrete work complete in any floor and at any height as per drawings except where specifically stated in the relevant item of Schedule of values, in strict accordance with this section of the specifications and the applicable drawings, and subject to the terms and conditions of the Contract.

7.2. SUBMITTALS

7.2.1. Suitable templates or instructions or both shall be provided for setting out 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.

7.2.2. For special concrete finish and for special methods of construction (e.g. slip forms) 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.

7.2.3. 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. The grading of the coarse and fine aggregates shall be tested at least once for every 6000 cft, to ensure that the grading is uniform and same as that of the samples used in the preliminary tests. Where doubt exists as to the suitability of the water, it shall be tested in accordance with BS 3148.

7.2.4. 'Workability' of Concrete 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 ASTM C 143.

7.2.5. 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.

7.2.6. Manufacturer's recommendations and instructions along with the sample of material shall be submitted to the Engineer for his approval. The CONTRACTOR shall, at his own cost, make optimum mix design and testing for approval of the composition of Non Shrinking grout and Non Shrink second stage Concrete Grout, prior to Commencement of the work.

7.2.7. 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. The proposal for transporting and erecting pre-cast units in position shall also be submitted by the CONTRACTOR for the approval of the Engineer.

7.3. CONCRETE STRENGTH

The concrete shall develop the following minimum cylinder strengths as per ASTM C 192, ASTM C 172 and ASTM C 31.

Sr. No.	Strength at 28 days (Pounds per Sq.Inch)	Corresponding Strength at 07 days (Pounds Per Sq.Inch)
1	4000	2650
2	3000	2000
3	2000	1400

7.4. CONSISTENCY

Frequent consistency tests shall be made with a slump cone as directed by the ENGINEER in accordance with ASTM C 143 and the water in the mix shall be controlled and adjusted as necessary to maintain nearly the following consistencies throughout the parts of the works:

ASTM C – 192 and UBC 1997 Section 1905 will be followed for maintenance of quality of concrete.

Type of Construction	Slump - inches
Mass concrete	1" – 1-1/2"
Reinforced foundations	1-1/2" - 2"
Beams & Slabs	1-1/2" – 2-1/2"
Walls	2" - 3"

7.5. ADMIXTURES

No admixtures shall be used without the approval of the ENGINEER (unless already specified) and the following procedure shall be followed if admixtures are proposed:

Intention to use admixtures shall be submitted with reasons justifying its use supported by manufacturer's literature, past experience and applicable standards.

If approved, trial mixes shall be prepared to arrive at a control mix design with admixtures and with suitable characteristics for the job.

Control mix shall be used on the job only if and where approved by the ENGINEER.

The admixtures shall be sampled at the source of supply and tested by an approved laboratory. An admixture which has been in storage at the Site for longer than 6 months or which has been subjected to freezing shall not be used until retest proves it to be satisfactory. Additional tests shall be made by the CONTRACTOR under the supervision of the ENGINEER.

7.6. MATERIALS

7.6.1. Aggregates

7.6.2. The sources of supply of all fine and coarse aggregates shall be subject to the approval of the Engineer. 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 to become dirty or contaminated. Fine aggregate shall be hard coarse sand, crushed stone or gravel screenings and shall conform to requirements of PS 243 and/or BS 882 and/or ASTM C 33. Only fine aggregate of grading zones 1 to 3 (BS 882) shall be used.

7.6.3. Coarse aggregate shall be crush stone of hard, durable material free from laminated structure and conforming to PS 243 and/or BS 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	
3 in.	(76.20 mm)	:	100
1.5 in.	(38.10 mm)	:	95-100
0.75 in.	(19.05 mm)	:	30-70

0.38 in.	(9.52 mm)	:	10-35
0.19 in.	(4.76 mm)	:	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	
1.5 in.	(38.10 mm)	:	100
0.75 in.	(19.05 mm)	:	95-100
0.38 in.	(9.52 mm)	:	25-55
0.19 in	(4.76 mm)	:	0-10

7.6.4. Wherever feasible, the nominal maximum size of aggregate for cast- in- place reinforced concrete slabs and other members shall be 3/4 inch. If there are difficulties in placing such concrete the maximum size may be restricted to 1/2 inch provided the requirements for strength are satisfied. The grading requirements of 1/2 inch or 3/8 inch down aggregate shall be agreed to with the Engineer as per relevant ASTM/BS standards. The nominal maximum size of the aggregate for precast concrete shall not be larger than one fifth of the narrowest dimension between sides of forms, or one-third of the depth of slabs or three-fourths of the minimum clear distance between reinforcing bars or between bars and forms, whichever is least. In Precast columns the nominal maximum size of the aggregate shall be limited as above but shall not be larger than two-thirds of the minimum clear distance between bars.

7.6.5. Coarse aggregates in precast concrete of normal weight may be of one maximum size for all concrete placed in 1 day when quantities to be placed are too small to permit economical use of more than one mix design. When a single mix design is so used, the maximum nominal size shall be as required for the most critical condition of concreting, in accordance with the requirements of clause (4.1.6) above.

7.6.6. Except where it can be shown to the satisfaction of the Engineer that a supply of properly graded aggregate of uniform quality can be maintained over the period of the work, the grading of the aggregates shall be controlled by obtaining the 19.05 mm maximum nominal size, the different size being stocked in separate stock piles and recombined in the correct proportion for each batch at the mixing plant. The materials shall be stock-piled for a period before use so as to drain nearly to constant moisture content (as long as site and other conditions permit, preferably for at least a day). The grading of the coarse and fine aggregates shall be tested at least once for every 6000 cft supplied to ensure that the grading is uniform and the same as that of the samples used

in the preliminary tests. For use in fireproof concrete, the aggregates shall be fire clay and semi-acidic fine ground. The use of broken fire clay bricks as coarse aggregate and waste of semi-acidic refractory particles as fine aggregate can be allowed.

7.7. CEMENT

7.7.1. 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 of PS 232 or BS 12 /EN 196-197 or ASTM C-150. For all fair faced concrete it will be necessary to use approved cement with a view to obtain light shade concrete as approved by the Engineer.

7.7.2. 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. There shall be sufficient cement at site to ensure that each section of work is completed without interruption. Cement reclaimed from cleaning of bags or from leaky containers shall not be used. The CONTRACTOR shall provide and erect (at his own cost) in a suitable plane, dry, well ventilated, weather-proof and water proof shed of sufficient capacity to store the cement.

7.7.3. 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 the CONTRACTOR'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. The mixing together of different types of cement will not be permitted.

7.8. WATER

7.8.1. 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 water can be shown to contain 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 percent of the strength of concrete mixed with distilled water.

7.8.2. Testing of Water

7.8.3. Tests on the purity, soluble sulphate, chloride or other chemical content, sediment and pH value shall be carried out as the ENGINEER may direct. The SUB-

CONTRACTOR shall supply all apparatus, labor and other facilities required for routine testing on Site and shall make available to the ENGINEER the results of all testing within 24 hours. In the event that the ENGINEER requires further independent testing of any water source or supply the CONTRACTOR shall arrange for the dispatch of samples of water to an approved analytical laboratory and shall pay all expenses incurred during such further testing. In addition to the above, the CONTRACTOR shall regularly carry out tests on the water used for concreting in accordance with ASTM D-596 and shall pay all expenses connected with such testing.

7.9. ADDITIVE

7.9.1. All additives such as foaming and water proofing agents shall be from a manufacturer approved by the Engineer. Air Entraining Admixtures shall conform to ASTM C 260. Other Admixtures shall conform to ASTM C 494.

7.10. MIXING CONCRETE

7.10.1. Mix all concrete in machine except that, in emergencies, the mixing may be by hand as approved by the Engineer but with 10% extra cement at the CONTRACTOR's cost. Produce homogeneous concrete mixtures of uniform colour, and discharge it without segregation. Accurately proportion and control all materials including water entering the drum. Discharge the entire batch before re-charging'; the volume of the mixed material per batch not to exceed the manufacturer's rated capacity of the mixer and each batch to remain in the mixer for a mixing period of not less than 2 minutes measured from the time when all the solid material is in the mixing drum. Introduce all the mixing water before one-fourth of the mixing period elapses.

7.10.2. Measure aggregate by approved gauge boxes made to dimensions suitable for measuring quantities by whole numbers of cement measures for a batch based on one bag cement. Do not remix concrete which has partially hardened, with or without additional cement, aggregate or water.

7.11. CONCRETING IN EXTREME WEATHER

Avoid concreting when weather is windy or resulting concrete temperature is above 100°F in hot weather or below 40°F in cold weather. If concreting is allowed by Engineer to be continued for the safety of the structure take all additional measures instructed by him.

7.12. PLACING CONCRETE

Get Engineer's approval to formwork, false work and reinforcement before concrete is place. During conveyance of concrete avoid segregation or separation or loss of ingredients, and place in its final position before initial setting of the cement has taken

place and within 30 minutes of the addition of water in the mix. When placed from a height of more than two meters, employ chutes etc; to ensure that no segregation takes place. The concrete shall be efficiently worked and worked around reinforcement steel work and embedded fixtures and into the corners of tile forms so that no voids or honeycombing occurs and no reinforcement or embedded fixtures are displaced. In forms for columns or walls and thin sections of considerable height, provide openings and other devices that will prevent segregation and accumulation of hardened concrete on the forms or reinforcement above the level of concrete. Clean steel before next pour of concrete. Keep record of the date of placing concrete in each part and section of the Works. No person shall walk on the steel reinforcement; walk on boards placed for the purpose.

7.13. COMPACTING CONCRETE

Compact all concrete by means of internal vibrators, but surface and external vibrators may be used either in conjunction with them or alone. Employ trained personnel to operate them. Continue vibration till the concrete is fully compacted and air bubbles cease to break the surface. Do not touch forms with internal vibrators and do not push the concrete along the forms. Avoid excessive vibration or tamping. Concrete members 100 mm or less thick shall not be vibrated with internal vibrators; compact such members by other approved means.

7.14. CONSTRUCTION JOINTS

Construction joints shall be as few as possible only at places shown on the Drawings or approved by the Engineer. Where concreting is stopped on a vertical plane as in beams, provide lap joint with approved stop board. Make provision to allow the reinforcement to pass through the joints without being temporarily bent or otherwise displaced. In the case of slabs or walls, nail a 50mm x25mm fillet slightly splayed (to permit easy removal) on the stop board to form a joggle running throughout the length of the joint. Remove any concrete flowing past the joint as soon as initial set occurs. When concreting against a hardened surface is resumed, well roughen, wet, clean the surface and apply cement sand slurry of same ratio as the mortar used in concrete and application of bonding agent. Provide approved water proofer in lieu of mortar at joints in basement and water retaining structures. In case of continuous retaining walls more than 10m long, carry out concreting such that vertical gaps of about one meter width with vertical joggled ends at both sides are left out at about 10m distances to be filled in after 14 days of concreting adjacent sections.

7.15. EXPANSION JOINTS

Expansion joints shall be provided wherever indicated on the Drawings or as directed by the Engineer. In no case shall the reinforcement, corner protection angles, or other embedded items be permitted to extend continuously through any expansion joint. All

expansion joints shall be carefully placed so as not to be displaced during concreting. The method of placing the expansion joints shall be strictly in accordance with the Drawings and/or as directed by the Engineer.

7.16. PROTECTION AND CURING OF CONCRETE

Protect concrete, after it is placed and during the early stages of hardening, from the harmful effects of sunshine, rain, wind, cold, heat, running water and shock. Prevent concrete from drying out for at least ten days. Do wet curing or employ other approved means. For columns, vertical wall surfaces and wherever water may not stand are as shall be covered with Hessian cloth and kept moist all the- time.

7.17. CONCRETING POUR LIFTS

Do not pour concrete in lifts of more than 2 m height. Pour concrete in one continuous operation in horizontal layers of uniform thickness not exceeding 300mm in depth and in walls at such rate of rise that adequate vibration can be ensured to avoid honeycombing and deformations of the formwork.

7.18. INSERTS AND OPENINGS IN CONCRETE

Start concreting after all types of inserts, conduits; pipes etc. and block out of openings have been placed as per drawings.

7.19. ALTERNATE BAY CONSTRUCTION OF NON-SUSPENDED FLOORS

Construct large areas of non-suspended floors in alternate bays; the area of the bay not to exceed 30 square meters for reinforced floors. Stop reinforcement 40 mm from the edges of the slabs. Use approved separators between panels if floors are required to be laid in independent panels.

7.20. NON-STRUCTURAL CONCRETE 1:2:4

7.20.1. DEFINITION

Non-structural concrete is the concrete for which no strength requirement is specified.

7.20.2. WATER/CEMENT RATIO

The quantity of water used shall be just sufficient to produce dense concrete of adequate strength and workability for its purpose. For all external work and foundations the water/cement ratio should not exceed 0.40 for concrete Class A, B and C.

7.20.3. PVC WATER STOP/HYDROFOIL

All PVC water stops/hydrofoil shall be central bulb type from a manufacturer approved by the 'Engineer'. The specific gravity of PVC water stop/hydrofoil shall not be less than 1.37 and full stretch Break cut intensity when tested at normal temperature shall not be less than 1875 psi. The material shall have a modulus of rigidity of 850 psi at +10° C and 10,500 psi. at 20° C.

7.21. DELIVERY, STORAGE AND HANDLING

Except where it can be shown to the satisfaction of the Engineer that a supply of properly graded aggregate of uniform quality can be maintained over the period of the work, the grading of the aggregates shall be controlled by obtaining 3/4" maximum nominal size, the different sizes being stocked in separate stock piles and recombined in the correct proportion for each batch at the batching plant. The material shall be stockpiled for a period before use so as to drain nearly to constant moisture content (as long as site and other conditions permit, preferably for at least a day). The SUB-Contractor shall provide and erect (at his cost) a suitable plain, dry, well ventilated, weatherproof and water proof shed of sufficient capacity to store the cement.

7.22. TRANSPORTING

The concrete shall be transported from the place of mixing to the place of final deposit as rapidly as practicable by means, which will prevent segregation or loss of ingredients. All skip vehicles, or containers used for transporting the concrete shall be thoroughly cleaned. During hot or cold weather, concrete shall be transported in deep containers, on account of their lower ratios of surface area to mass, which reduces the rate of loss of water, by evaporation during hot weather and loss of heat during cold weather.

7.23. PLACING

7.23.1. The CONTRACTOR shall note that placing of concrete will be done with appropriate manner. 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 by the Engineer.

7.23.2. 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. 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. The concrete after it has been mixed shall be placed as soon as it 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.

7.23.3. 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, or 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 including consolidation does not exceed 15 minutes under any circumstances. Any concrete which does not satisfy this requirement shall be rejected. Concrete shall be deposited as nearly as possible in its final position to avoid segregation due to rehandling or flowing. In no circumstances may concrete be railed or made to flow along the forms by the use of vibrators.

7.23.4. The free fall of concrete shall not be allowed to exceed 6 feet. 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 9 inch in diameter. 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. 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 and 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 .082 lb./ft² will then be laid flat to separate the concrete from the surface on which it is to be laid.

7.23.5. Concrete shall be deposited continuously, or in layers 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 spreaders 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. Every CONTRACTOR whose work is related to the concrete or services or must be supported by it shall be given ample notice and opportunity to introduce and/or furnish embedded items before the concrete is placed.

7.24. CONSTRUCTION JOINTS

7.24.1. Construction 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 and columns shall be at the underside of floors, slabs or beams and at the top 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. All reinforcing steel shall be continued across joints. Keys and inclined dowels shall be provided as directed by the Engineer. Longitudinal keys at least 1-1/2 inches deep shall be provided in all joints in walls and between walls and slabs or footings.

7.24.2. When the work has to be resumed on a surface which has hardened, such surface shall be roughened in an approved manner which will expose the aggregate uniformly and will not leave laitance, loosened particles of aggregate or damaged concrete at the surface. The hardened concrete of construction joints and of joints between footings and walls or columns, between walls or columns and beams or floors they support, joints in un-exposed walls and all others not mentioned herein shall be dampened (but not saturated) immediately prior to placing of fresh concrete.

7.24.3. The hardened concrete of joints in exposed work, joints in the middle of beams, and slabs; and joints in work designed to contain liquids shall be dampened (but not saturated) and then thoroughly covered with a coat of cement grout similar in proportions to the mortar in the concrete. The grout shall be as thick as possible on vertical surfaces and at least 1/2 inch thick on horizontal surfaces. The fresh concrete shall be placed before the grout has attained initial set. Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle, and brushed, care being taken to avoid dislodgment of particles of aggregate. The surface shall then be coated with neat cement grout. The first layer of concrete to be placed on this surface shall not exceed 6 inch in thickness, and shall be well rammed against old work, particular attention being paid to corners and closed spots.

7.24.4. Stop ends for movement joints or construction joints shall be made by splitting them along the lines of reinforcement passing through them, so that each portion can be positioned and removed separately without disturbance or shock to the reinforcement or the concrete. Stop ends made of expanded metal or similar material may only be left permanently in the concrete with prior written approval of the Engineer. Where such stop ends are used, no metal may be left permanently in the concrete closer to the surface of the concrete than the specified cover to the reinforcement.

7.25. PLACING AND CONNECTION OF WATER-STOPS

The water-stops and expansion joint material shall be positioned accurately and supported against displacement as shown on the drawings.

7.26. ELECTRIC CONDUITS AND PIPES

7.26.1. Electric conduits and other pipes which are planned to be embedded shall not, with their fittings, displace more than four percent of the area of the cross section of a column on which stress is calculated or which is required for fire protection. Sleeves, conduits, or other pipes passing through floors, walls, or beams shall be of such size or in such location as not to impair unduly the strength of the construction; such sleeves, conduits, or pipes may be considered as replacing structurally in compression the displaced concrete, provided that they are not exposed to rusting or other deterioration, are of uncoated or galvanized iron or steel not thinner than standard steel pipe, have a nominal inside diameter not over 2 inch and are spaced not less than three diameters on centres. Except when plans of conduits and pipes are approved by the Engineer, embedded pipes and conduits other than those merely passing through, shall not be larger in outside diameter than one third the thickness of the slab, wall, or beams in which they are embedded nor so located as to impair unduly the strength of the construction. Sleeve pipes, or conduits of any material not harmful to concrete and within the limitations of this section may be embedded in concrete with the approval of the Engineer provided they are not considered to replace the displaced concrete.

7.26.2. All sleeves, inserts, anchors, and embedded items required for adjoining work or for its support shall be placed prior to concreting. Voids in sleeves, inserts and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids. 'Mass-concrete' shall be placed in layers approximately 18 inch thick. Vibrator heads shall extend into the previously placed layer.

CONSOLIDATION

7.26.3. All concrete shall be consolidated by vibration, spading, rodding or forking so that the concrete is thoroughly worked around the reinforcement, around embedded items and into corners of forms, eliminating all air or stone pockets which may cause honeycombing, pitting, or planes of weakness. Internal vibrators shall have a minimum frequency of 8000 vibrations per minute and sufficient amplitude to consolidate the concrete effectively. They shall be operated by competent workmen. Use of vibrators to transport within forms shall not be allowed. Vibrators shall be inserted and withdrawn at points approximately 18 inch apart. At each insertion, the duration shall be sufficient to consolidate the concrete but not excessive so as to cause segregation, generally from 5 to 15 sec. A spare Vibrator shall be kept on the job site during all concrete placing operations.

7.26.4. Where the concrete is to have an as-cast finish, a full surface of mortar shall be brought against the form by the vibration process, supplemented, if necessary, by spading to work the coarse aggregate back from the formed surface. If there is any tendency for the mix to segregate during consolidation, particularly if this produces excessive laitance, the mix proportions shall be modified to effect an improvement in the quality of the concrete to the satisfaction of the Engineer and in conformity with the provisions of Clause 5.

7.26.5. Vibrator shall not be allowed to contact the formwork for exposed concrete surfaces. Mechanical vibrators shall be of a type suited in the opinion of the Engineer to the particular conditions. Over-vibration or vibration of very wet mixes is harmful and should be avoided.

7.27. APPLICATION OF NON-SHRINK GROUT

7.27.1. Concrete surfaces to receive non-shrinking grout shall be roughened, cleaned and dampened. Form shall be provided to retain the grout until sufficiently hard to support itself. Grout shall be poured in place and thoroughly rodded or washed to prevent the formation of voids. After non-shrink grout has received its initial set, it shall be kept damp for 24 hours.

7.27.2. Placing of Vapour Barrier

Vapour barrier shall be laid in position wherever shown on the Drawings. The material shall be supplied in rolls and laid by rolling over the prepared surface at the levels and position in the areas shown on the Drawings. Where joint is necessary at the side or end of a sheet, this shall be a double weld folded joint made by placing the edges together and folding over twice continuously taking the top edge prior to concreting. The CONTRACTOR shall protect the film sheets from damages during laying and subsequent operations and shall replace at his own cost all damaged film sheets to the satisfaction of the Engineer.

7.28. CEMENT CONCRETE PAVEMENTS

7.28.1. Full co-operation shall be given to trades like electrical, mechanical and other services. For all concrete work relevant specifications of this section shall apply. Side Forms and Construction. Side forms shall be of steel or any other suitable material and of a design as approved by the Engineer. In general, only materials and methods that have proved their acceptability by past performance will be considered. All form shall be constructed so that they can be removed without hammering or prying against the concrete.

7.28.2. Horizontal joints in the forms will not be permitted. Forms shall be thoroughly cleaned and oiled with linseed/mineral oil shall be given two coats of niter-cellulose lacquer each time they are used.

7.28.3. The forms shall be set on a thoroughly compacted base true to line and level and firmly secured in position by appropriate methods. Conformity with the alignment and levels shown on the Drawings shall be checked as and when required by the Engineer. Where necessary corrections shall be made immediately before placing the concrete; where any form has been disturbed it shall be reset and rechecked.

7.28.4. Pavements shall be constructed in panels of sizes as shown on the Drawings. The panels shall be laid alternately, the adjoining panels being concreted when the side forms are struck and the jointing materials placed, inspected and approved by the Engineer. Each panel is to be concreted in one operation and no interruptions shall be permitted during the operation. The concrete shall be tipped from the trolley slightly in advance of the working place and then shoveled into position. The spreading shall be carried out very carefully. Compaction shall be done by means of vibro-compactors of approved surface vibrators. If a vibro-compactor is used, it shall be operated on the concrete and will not be allowed to strike or displace the forms. The spreading and compacting of the successive layers shall proceed without interruptions and as quickly as practicable so as to ensure that the slab is monolithic throughout its depth.

7.28.5. The wearing surface shall be laid while the base concrete is still wet and screeded to line and level. When the initial set takes place the surface shall be troweled smooth with a steel trowel to provide a dense closed surface.

7.28.6. All the joints shall be carefully formed as shown on the Drawings or as directed by the Engineer. The joint filler together with performed groove shall provide complete separation of adjacent slabs. The joints shall all be sealed with bitumen as shown on the Drawings and as directed by the Engineer.

7.29. PROTECTION AND CURING

7.29.1. 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 approved water 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 portions of 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, which may break the membrane, for the full period of curing. The membrane curing compound shall be colorless or light colored and shall be approved by the Engineer and shall comply with ASTM Designation C 309.

7.29.2. Curing Periods

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

7.29.3. 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 injury resulting from the storage or movement of material during construction.

7.29.4. 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 shed clean. Plastering of surface, application of cement or other coating will not be permitted. All exposed corners shall be chamfered, 1"x 1" (2.5 cms x 2.5 cms) 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. Spreading, finishing and floating of concrete in pavements

7.30. GENERAL REQUIREMENTS

The striking off, compacting and floating of concrete shall be done by mechanical methods, if approved by the Engineer. Where the Engineer determines that it is impracticable to use mechanical methods, manual methods of spreading, finishing and floating may be used on pavement lines as indicated on the Drawings.

7.31. MANUAL METHODS

When striking-off and compacting by manual methods is permitted, the concrete shall be leveled and then struck-off to such an elevation that, when properly compacted, the surface will conform to the required grade and cross-section. The strike board shall be moved forward with a combined longitudinal and transverse motion, the manipulation being such that neither ends is raised from the side forms during the process. While striking off, a slight excess of concrete shall be kept in front of the cutting edge at all times. Prior to tamping, the concrete along the forms shall be thoroughly spaded or vibrated. The entire area of pavement shall be tamped or vibrated a manner that will ensure maximum compaction. The concrete shall be brought to the required grade and shape by the use of a tamper consisting of a heavy plank whose length exceeds the width of the pavement by 1 foot or by the use of a mechanical vibrating unit spanning the full width of the spread. The tamper shall be constructed with properly trussed roads to stiffen it and prevent sag and shall be shod with a heavy strip or metal for a tamping surface. The tamper shall be moved with a combined tamping and longitudinal motion, raising it from side form and dropping it so that the concrete will be thoroughly compacted and rammed into place. A small surplus material is compacted and rammed into front of the tamper or vibrating unit and tamping or vibrating shall continue until the true cross-section is obtained and the mortar flushes slightly to the surface.

7.31.1. On grades in excess of 5 percent where hand methods are permitted, a little strike board shall follow at a speed of 25 ft to 50 ft per hour back of the heavy strike board, and shall be used in the same way, so as to remove waves caused by flow of concrete.

7.31.2. Where hand tamping is permitted, not less than two strike boards or tampers shall be used for production in excess of 350 Cu.ft. After the concrete has been compacted, it shall be smoothed with a wooden float where necessary, as directed by the Engineer.

7.32. LONGITUDINAL FLOATING

Manual floats shall be at least 12 ft. in length not less than 6 inches in width and shall be properly stiffened to prevent bending or warping. In using the float, it shall be held parallel to centre line of the pavement at all time and shall be moved laterally across the pavement from one side or edge to the other until all high areas are cut down and floated into depressions, leaving a surface that is smooth and true to grade. Batch transverse passage of the longitudinal manual float shall lap the proceeding passage by half.

7.33. FIRST STRAIGHT EDGE TESTING

7.33.1. Immediately following final floating the entire area of the pavement shall be tested with a 10-ft. (approx. 3. meters) straight edge. Any depressions found shall be immediately filled with fresh concrete which shall be struck off compacted and finished. High areas shall be worked down and refinished. The straight edge testing and refloating shall continue until the pavement has the required surface contour.

7.33.2. Burlap (Coarse Canvas) Dragging

After the first straight edge testing and when most of the water sheet has disappeared from the surface and just before the concrete becomes non-plastic, the surface shall be dragged with a strip of burlap (coarse canvas) 3 ft. to 10 ft. wide and having a length 4 ft. more than the width of the slab. The burlap shall be dragged along the surface of the pavement in a longitudinal direction. Burlap shall be clean and kept free from coatings of hardened concrete. It shall be moist at the time of use.

7.33.3. Second Straight Edge Testing

After the concrete has hardened sufficiently to permit walking on it, the surface of the pavement shall again be tested with a 10-ft. straight edge. Any portion of the pavement which shows a variation from the testing edge of more than 1/8 inch shall be corrected by cutting, or shall be removed and replaced at the expense of the CONTRACTOR.

7.34. EXPANSION AND CONTRACTION JOINTS

7.34.1. All the expansion and contraction joints shall be carefully formed as shown on the Drawings or as directed by the Engineer. As regards dowel bars and joint assemblies, such stakes, brackets or other devices shall be used, as necessary to keep the entire joint assembly in true vertical and horizontal position. The joint filler together with the preformed groove shall provide complete separation of adjacent slabs. The joints shall all be sealed with the specified non-extruding sealing compound set in a 3/4 inch wide preformed chase as shown on the Drawings. The preformed chase shall be thoroughly cleaned of all dust, debris, stones or other hard material prior to its sealing. The riser of all joints shall be rounded to a radius as shown on the Drawings before the concrete hardens.

7.34.2. The joints sealing compound shall be hot poured bitumen or approved sealing compound for concrete pavements complying with BS-2499 for hot tropical climates and heavy duty industrial site subject to severe exposure. All joints are to be filled with flexell expansion joint filler, or an approved elastic, compressible, durable and rot-proof equivalent of sufficient rigidity to enable it to be satisfactorily installed in the joint and resist deformation during the passage of the concreting equipment. The filler is to be of the same thickness as the joint width. Holes to accommodate the dowel bars shall

accurately be drilled or punched out. Where shown on the Drawings, dowel bars of required diameter shall be placed at the specified spacing. The bars shall be lubricated with an approved lubricant. One end of the dowel bar at expansion joints shall be provided with a closely fitting sleeve 3 inch long, consisting of bitumen coated plastic or other approved material to permit expansion. A loose plug 1 inch deep of approved compressible filling material shall be inserted into the sleeve as shown on the Drawings at the end of the bar. All the dowel bars shall be mild steel bars of the size shown on the Drawings and shall conform to the requirements as specified in the section 'Concrete.

7.34.3. Contraction joints shall be provided as shown on the Drawings. The assembly and method of constructing the expansion joints/contraction joints shall be subject to the approval of the Engineer.

7.34.4. In general all PVC water stops/hydrofoil shall be placed in the centre of the structural member. Each piece of the water stop-hydrofoil shall be of maximum practicable length. An ordinary sharp knife saw or any other sharp tool can be used to cut the water stop. Joints at inter sections and at ends of pieces shall be made in the manner most appropriate to the material being used. Joints shall develop effective water tightness fully equal to that of the continuous water stop material and shall permanently retain their flexibility. For straight line connection-melting method of connection can be used by passing two water stops intended for connection against a heated iron or copper sheet. When they are melted, the two are combined.

7.34.5. After joining, the water stop should be allowed to cool. For all other connections such as T-type or L-type, the welding method of joining should be used. Welding rod of same material as the water stop shall be used. The welding rod & the water stop shall be heated & melt at the same time, by means of heated air jetting from the hot jet gun.

7.35. CONCRETE COVER

The minimum concrete cover to reinforcement excluding stirrups and binders, shall be as indicated on the Drawings unless otherwise directed.

The minimum cover will normally comply with the following requirements:

For Normal Construction

On all external faces: 2"~3"

On all other faces: 3/4"

Notwithstanding the above provision the cover to any bar shall be not less than the diameter of that bar.

For Water Retaining Structures

Faces exposed to fresh (Potable) water: 1-1/2" OR 40mm

Faces exposed to effluent and other impure water: 2" OR 50mm

For unscreeded ground-bearing, ground floor slabs: 2" OR 50mm

Provided always that the required minimum cover is maintained, the actual cover to any bar shall be that indicated on the Drawings with the following tolerances:

Plus or minus 5 mm or 1/4" on bars up to and including 12 mm or 1/2" diameter.

Plus 10 mm or 3/8" or minus 5 mm or 1/4" on bars over 12 mm or 1/2" up to and including 25 mm or 1" diameter.

Plus 16 mm or 5/8" or minus 5 mm or 1/4" on bars over 25 mm or 1" diameter.

7.36. TEST OF CONCRETE QUALITY

7.36.1. 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. 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. All tests shall be carried out at laboratories approved by the ENGINEER. The ENGINEER may be present during testing.

7.36.2. Preliminary cylinder tests and works cylinder test shall be performed in accordance with the discretion of the ENGINEER. The standard of acceptance for preliminary and works tests shall be as given below.

7.36.3. Strength Tests During the Work: Strength tests of the concrete placed during the course of the work shall be made by the CONTRACTOR. The CONTRACTOR shall test, for control purposes, such number of cylinders as the ENGINEER may direct.

7.36.4. In general three sets of three cylinders each shall be taken from each 250 cubic feet or fraction thereof or from each day's pour, whichever is less, of each class of concrete placed. Test specimens shall be made and cured in accordance with the applicable requirements of ASTM C-31. Specimens shall be cured in the manner and environments as the pertinent structure.

7.36.5. Cylinders shall be tested in accordance with the applicable requirements of ASTM C-39 and ASTM C-78. The test result shall be based on the average of the strength

of the test specimens except that if one specimen in a set of three shows manifest evidence of improper sampling, moulding or testing, the test result shall be based on the average of the remaining two specimens. If two specimens in a set of three show such defects, the results of the set will be discarded and average strength determined from test results of the other two sets.

7.36.6. The standard age of test shall be 28 days, but 7-day tests may be used at the discretion of the ENGINEER, based on the relation between the 7-day and 28-day strengths of the concrete as established by tests for the materials and proportions used. If the average of the strength tests of the specimens for any portion of the work falls below the minimum allowable compressive strength at 28-days required for the class of concrete used in that portion, the CONTRACTOR may change the proportions of the constituents of the concrete, as necessary to secure the required strength for the remaining portions of the work. Tests of Hardened Concrete in or Removed from the Structure:

7.36.7. Where the results of the strength tests of the control specimens indicate that the concrete as placed does not meet Specification requirements, or where there is other evidence that the quality of the concrete is below Specification requirements, core-boring tests will be made by the ENGINEER in accordance with the applicable requirements of ASTM C- 42 entirely on the expense of the CONTRACTOR. If the concrete in the structure will be more than superficially wet under service conditions, the cores shall be immersed in water for at least 48 hours and tested wet. In the event that the core-boring test indicates that the concrete placed does not conform to the Drawings and Specifications, measures as prescribed by the ENGINEER shall be taken to correct the deficiency.

7.36.8. However, the ENGINEER shall have the authority to prescribe such corrective measures, and the CONTRACTOR shall take such measures if in the ENGINEER's opinion the results of the test specimens, without coring, warrant such action. If a strength deficiency is found and is in the opinion of the ENGINEER due to the SUB-CONTRACTOR's fault or negligence, the entire cost of replacing faulty concrete or carrying out prescribed corrective measures shall be borne by the CONTRACTOR.

7.37. 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 encrustation's.

7.38. SAMPLES:

7.38.1. 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. Similar samples of in-situ concrete for approval by the Engineer submit two samples, 2 Sq. ft. of each type of exposed in-situ concrete. All in-situ samples will remain at the construction site.

7.38.2. Sample approvals of precast & in-situ concrete:

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

7.39. FORMS

7.39.1. 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.

7.39.2. If wood forms are chosen to be used by the CONTRACTOR they shall be constructed of 3/4 inch minimum thickness plywood constructed in a fashion to allow many re-uses with all surfaces sealed with a polyurethane varnish.

7.39.3. 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 polyurethane varnish. Re-use of forms shall be subject to approval by the Engineer.

8. FLOORING

8.1. SCOPE

The work under this section of the Specification consists of furnishing all plant, labor, equipment, appliances and materials and performing all operations in any floor and at any height in connection with the installation of cement concrete floors and floor finishes including bases, skirting and surface treatments, complete in strict accordance with this section of the specifications and the applicable drawings and subject to the terms and conditions of the Contract.

8.2. SUBMITTALS

CONTRACTOR shall submit at least 3 range samples of all the items/each type of stone/tile to be provided under this section showing color, grade, finishing and texture to the Engineer for approval. CONTRACTOR shall provide samples from each specified manufacturer and in sufficient variation for each type of item. The Engineer shall make his selection only when all related samples have been submitted and he is satisfied that the samples submitted are the maximum range available against any item.

8.3. MATERIAL

8.3.1. STONOLITHIC/GRANOLITHIC FLOORING

8.3.1.1. CEMENT

Cement shall be ordinary Portland confirming ASTM C-150 PS232-2008 (R-OPC-43)

8.3.1.2. SAND

Sand shall be obtained from sources approved by the Engineer. The grading shall confirm to B.S 882 Grading which the gradation limits are as follows:-

Percentage (by weight) passing

<u>B.S. Sieve</u>	<u>Grading</u>
3/8" (9.53 mm)	100
3/16" (4.765 mm)	90-100
No. 7	75-100
No. 14	55-90

No. 25	35-59
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No. 52	8-30
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No. 100	0-10
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8.3.1.3. 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 matters injurious to concrete. All coarse aggregate shall conform to BS 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" (9.53 mm)	20-55
3/16" (4.765 mm)	0-10

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

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

Any aggregates not found to be of the specified/approved standard shall be rejected by the Engineer and all such rejected material shall be removed from site without delay.

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

8.3.1.4. BRICK BALLAST

Brick ballast to be used as soling shall conform to specifications of "Brick Masonry" or using crush as per direction of Engineer.

8.3.1.5. 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.

8.4. INSTALLATION OF FLOORING

Earth / structural fill be leveled, watered and compacted at optimum moisture content either by hand rammers or mechanical compactors to achieve 95% modified dry density as per AASHTO standards.

6" thick layer of crushed stone aggregate with screening will be placed on top of compacted earth / structural fill and then leveled, watered and compacted manually or mechanically to achieve in situ dry density of 95% when tested as per AASHTO standards.

4" thick P.C.C. 1:4:8 will be placed on top of crushed stone layer as per specifications specified for cement concrete under "concrete". Water will be sprinkled to wet minimize absorption of cement slurry from the PCC 1:4:8.

The surface will be kept damp for at least seven days and then allowed to dry for at least seven days to ensure that the surface is absolutely dry.

Two coats of bituflex will be applied on top of PCC 1:4:8 after cleaning the surface with wire brushes and blowing out of all the dust from the upper surface of PCC 1:4:8. The bitulfex will be applied at the rate of 20 pounds per 100 square feet per coat.

Method of mixing and laying of reinforced cement concrete floors shall be as specified for cement concrete under "Concrete". Cement concrete shall be laid as per ACI 304 and specified in the "Concrete". Unless otherwise specified cement concrete used for topping shall be P.C.C. 1:2:4. Before laying concrete the base surface shall be cleaned and wetted so that it is well bounded. The concrete after laying shall be finished by tamping the concrete with straight edges to bring the surface to the required smooth, even, impervious finish level with no coarse aggregate visible and free from trowel or other such marks. While the concrete is still green it shall be roughened where topping is to be laid directly on concrete. When the concrete is sufficiently hardened to bear a man's weight without deep imprint, it shall be wood floated to a true even plane with no coarse aggregate visible. Just so much pressure shall be used on the wood floats as to bring moisture to the surface.

Concrete shall be left undisturbed for 24 hours after laying. During laying and 14 days thereafter the concrete shall be kept wet and protected from weather and extreme temperatures. In no case shall hammering be allowed on a finished surface.

Method of laying and finishing tile floor shall be as specified under "Tile Work". The floor shall be laid truly level at top in one plane horizontal or sloping as directed by the ENGINEER and as shown in the drawings and specified for tile work.

9. TILE, GRANITE AND FLOOR FINISHES

9.1. SCOPE

The work covered by this section of the Specifications, consists of furnishing all plant, labor, equipment, appliances and materials and in performing all operations in connection with the installation of tiles 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 the Contract. The scope of this section of Specification is covered with detailed specifications as laid down herein.

9.2. SUBMITTALS

CONTRACTOR shall submit at least 3 range samples of all the items/each type of stone/tile/granite/marble/corian/rubber/carpet to be provided under this section showing color, grade, finishing and texture to the Engineer for approval. CONTRACTOR shall provide samples from each specified manufacturer and in sufficient variation for each type of item. The Engineer shall make his selection only when all related samples have been submitted and he is satisfied that the samples submitted are the maximum range available against any item.

9.3. APPLICABLE STANDARDS

Latest editions of following standards are relevant to these specifications wherever applicable.

ASTM (American Society for Testing and Materials):

C 482 Bond strength of Tile to Portland cement.

C 648 Breaking Strength of Tile.

C 650 Resistance of tile to Chemical substances.

C 798 Color Performance of glazed tile.

BSI (British Standard Institution):

1281 Glazed tiles and tile fittings for internal walls.

5442 Classification of Adhesives for construction.

203 Sheet and Tile Flooring.

209 Care and Maintenance of Floor Surface.

9.4. MATERIAL

9.4.1. CEMENT

Cement shall be ordinary Portland confirming ASTM C-150 PS232-2008 (R-OPC-43)

9.4.2. SAND

Sand shall be obtained from sources approved by the Engineer. The grading shall confirm to B.S 882 Grading which the gradation limits are as follows:-

Percentage (by weight) passing

<u>B.S. Sieve</u>	<u>Grading</u>
3/8" (9.53 mm)	100
3/16" (4.765 mm)	90-100
No. 7	75-100
No. 14	55-90
No. 25	35-59
No. 52	8-30
No. 100	0-10

9.4.3. 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 matters injurious to concrete. All coarse aggregate shall conform to BS 882 and shall be graded as follows:

<u>B.S. Sieve</u>	<u>% Passing by weight</u>
1" (25.40 mm)	100
3/4" (19.05 mm)	90-100
3/8" (9.53 mm)	20-55

3/16"(4.765 mm)

0-10

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

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

Any aggregates not found to be of the specified/approved standard shall be rejected by the Engineer and all such rejected material shall be removed from site without delay.

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

9.4.4. 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.

9.4.5. GLAZED / UNGLAZED TILES

Glazed tiles shall comply with BS 1281 or the requirements ASTM C609, C648, C650, C798. Tiles shall be of standard grade. Unglazed tiles shall comply with BS 1286.

The tiles shall be free from cracks or crazing, free from twisting and uniform in color. Tiles shall be obtained to the size and thickness indicated on the drawings.

All tiles shall be in colors selected by the Engineer from the manufacturers' range of standard colors in the standard grade of products.

Prior to commencement of work the CONTRACTOR shall submit to the Engineer three samples of each type of tiles of all available color and patterns for his approval.

Manufacturers published literature containing instructions and recommendations shall also be submitted.

The glazed/unglazed tiles shall be laid on cement concrete base of specified grade and the joints filled with neat white or gray cement including vertical and horizontal covers.

9.4.6. GRANITE/MARBLE/CORIAN SLABS

Granite / Marble Slabs conforming to following standards.

Hard Granite / Marble free of veins, blemishes will be obtained from quarry and cut to sizes as required and shown on drawings.

Granite will be pre-polished

Marble will be polished and grinded

Slabs will be hard enough to with stand chemicals attack.

Slabs will be detergent resistant

Slabs will be non-absorbent

Slabs will not absorb blood and will resist staining by blood.

Slabs will be cut to desired thickness and size prior to installation.

Cement, sand, aggregate and water shall be in conformity with the specifications laid down under the Section "FLOORING".

9.4.7. RUBBER FLOORING

Deleted.

9.4.8. CARPET FLOORING

-DELETED-

9.4.9. TERRACOTTA TILES

DELETED.

9.5. LAYING/INSTALLATION

9.5.1. LAYING OF TILES/SLABS

The curing period of the setting bed shall be as directed by the Engineer. As large an area of setting bed shall be spread at one time as can be covered with tiles/slabs before the base has set. Surplus base material shall be removed. The thickness of setting bed shall not be less than the thickness specified in the Drawings.

Floor and other surfaces to receive the tiles/slabs shall be thoroughly cleaned of all dirt, dust oil and other objectionable matters. Tiles/Slabs shall be laid out from the center 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/slabs shall be of uniform width. Tiles/Slabs shall be cut with an approved cutting tool and rough edges shall be rubbed smooth. Tiles/Slabs shall be laid to straight edges.

The floor and other finished surfaces should be kept wet for at least 72 hours and man traffic should not be allowed on the tiles during the period.

Install components plumb, level and rigid, scribed to adjacent finishes, in accordance with approved shop drawings and product data.

10. BRICK MASONRY

10.1. SCOPE

The work under this section of the specifications consists of furnishing all plant, labor, equipment, appliances and materials and performing all operations in any floor and at any height in connection with furnishing and installing brick masonry in position including Portland cement and sand for mortar & masonry, complete in strict accordance with this section of the specifications and applicable drawings.

10.2. SUBMITTALS

Samples of first 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, the Engineer finds use of sub-standard material, such work shall be rejected and the CONTRACTOR shall replace the rejected work at his cost.

10.3. QUALITY ASSURANCE

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 bricks 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.

10.4. DELIVERY AND STORAGE

The methods and equipment used for transporting the bricks and mortar shall be such as will not damage the bricks nor delay the use of mixed mortar. Masonry materials shall be so stored that at the time of use the materials are clean and structurally suitable for use.

10.5. STACKING, SAMPLING AND TESTING

Sort out and arrange the bricks in stacks of one or two thousands or as directed by the Engineer. Each stack shall be 10 courses high and two bricks thick so that at least 0.6 meter space between the stacks shall be left for the purpose of inspection. Stack each size or class of brick separately. For purposes of inspection and tests, the sample bricks shall be selected by the Engineer.

10.6. BRICK

10.6.1. All brickwork shall be erected plumb and true to line and level with maximum variation in any story height or any length of wall being one mm in one meter.

10.6.2. All bricks shall be of first class quality made from good brick earth, free from saline deposit and shall be hand moulded as per approved manufacturer list. They shall be thoroughly burnt without being vitrified, 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 oven dried condition shall not absorb more than $\frac{1}{5}$ of its weight of water when immersed one hour in water at 21 to 27 degrees centigrade and shall show no signs of efflorescence on subsequent drying. The average compressive strength of five representative first class bricks shall be not less than 1800 psi and not less than 1500 psi for any individual brick.

10.6.3. 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.

10.6.4. 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. Over-size, irregular and worn moulds shall be destroyed. Each finished brick for brick masonry shall be 9" by 4-1/2" by 3" in size and shall weigh between 7 lb. to 9 lb. All bricks shall have a "frog" 1/4" deep on one face.

10.6.5. Cavity Wall is a wall comprising of two leaves, each leaf being built of masonry units and separated by a cavity so as to provide an air space within the wall and tied together with metal ties or bonding units to ensure that two leaves act as one structural unit. The width of the cavity shall not be less than 30 mm and not more than 115 mm. The space between the leaves being either left as cavity or filled with non-load bearing insulating and water proofing material.

10.6.6. Metal Ties may be of galvanized iron, wrought iron, gun metal, brass, copper, stainless steel or any such corrosion resistant metal, made of flats 20 x 5 mm cranked or twisted at their mid-point with ends split and fish tailed. The ties shall be built into horizontal bed joints during erection, placed sloping towards the exterior side to prevent water from flowing along it from outer to inner leaf side.

10.6.7. Bonding Units length will be sum of thickness of both leaves plus width of cavity if the leaves are 75 mm or 115 mm. If the leaves are more than 115 mm thick, then the length of a unit will be $[(2 \times 115) + \text{width of cavity}]$.

Cement concrete used in the bonding units shall not be leaner than 1:3:6 (1 cement: 3 sand : 6 aggregate 20 mm nominal size).

10.6.8. Metal ties/bonding units shall be spaced not more than 90 cm apart horizontally and 45 cm vertically and staggered in each course. Additional ties shall be used near openings.

10.6.9. Cavity walls shall not normally be built more than 7.5 meters in height and 9 meters in length. Where large lengths and heights are desired, the wall shall be divided into panels with strengthening measures such as pillars etc. Cavity shall be covered at the top with at least two courses of masonry unit and/or a coping over it. Adoption of cavity walls is not recommended when heavy concentrated load from beam etc. are to be supported by walls.

10.7. MORTAR

10.7.1. Mortar for first class brick masonry, except where otherwise directed by the Engineer, shall consist of one part Portland cement to five 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.

10.7.2. 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. Re-tempering of mortar shall not be allowed.

10.8. EXECUTION

10.8.1. Soaking and washing bricks

Before use, soak bricks in clean water for at least 4 hours. If bricks contain soluble salts liable to cause efflorescence, wash bricks thoroughly to satisfaction of the Engineer using diluted HCL (1:40 litre)

10.9. PLACING / FIXING

10.9.1. 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 kept wet by soaking in 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.

10.9.2. 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 3/8" 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 one another. Excess mortar at the outer edges shall be removed and joints drawn straight with the edge 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 repainted. Care shall be taken during construction of cavity walls so as to avoid the filling up of cavity with mortar. G.I. flashing and weep holes shall be provided where ever specified on the drawings or as per the instructions of the Engineer. Weep-holes will be formed by oiled rods, removed after the mortar is set, at specified locations.

10.9.3. The external face of brick masonry surface of the exterior walls (where ever shown or as directed by the Engineer) shall be finished by English/ Flemish bond and by deep struck pointing as the work proceeds. The joints shall be struck by the help of a pointing tool to provide a notch in the green mortar after the brick work has been laid. 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 edge as the object of striking the joint is to compress the mortar into the joints.

10.10. ANCHORING

All brick masonry shall be bonded to concrete columns/walls/beams with steel anchors as per details provided in drawing. Anchors/wall ties as specified or as instructed by the Engineer shall be provided in cavity walls.

10.11. CURING AND REPAIR

10.11.1. 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 continuously

wet. Water used for curing shall meet the requirements of the Specifications for water used in the manufacture of bricks.

10.11.2. 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 expense unless the Engineer grants permission, in writing, to patch or replace the defective area.

10.12. SCAFFOLDING

10.12.1. 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 SUB-Contractor in the unit rate for masonry items.

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

10.13. TESTING

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 1/8" in 10 feet. The maximum tolerance in the length, height or width of any single masonry unit shall be $\pm 1/8"$.

10.14. DAMP PROOF COURSE

All damp proof course unless otherwise specified shall consist of class 'C' cement concrete 2" thick, mixed with approved quality water proofing compound (SIKA/ MBT/ Approved equivalent) as per manufacturer's specifications and shall be laid at required 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 materials as specified on the Drawings.

11. WOOD WORK

11.1. SCOPE

The work covered under this section of Specifications consists of providing all material, labour, plant, equipment, appliances and performing all operations in any floor and at any height connected with the fabrication and erection of all woodwork, mill work, construction assembly, surface finish 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.

11.2. SUBMITTALS

The Engineer shall approve all samples of the material used for the work under this Section of Specification 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.

11.2.1. Provide manufacturer's literature completely describing products.

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

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

11.2.4. Submit samples of MDF, Wood, Plywood, Formica, etc. for selection of texture/colour, quality and grain.

11.2.5. Procurement of materials shall be made only after the submittal of shop drawings and samples and their approval by the Engineer.

11.2.6. MOCK-UP SAMPLE

After approval of shop drawings and tests etc., the CONTRACTOR shall submit one mock-up sample of each type of wood work complete with all fixing, fixtures accessories prior to the actual fabrication of the bulk. No extra payment shall be admissible to the SUB-Contractor on this account.

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

11.3. MATERIAL

11.3.1. HARD WOOD

Hard wood shall comprise of Ash, beech, Walnut Mahogany, Teak, Iroko and Sheesham.

11.3.2. SOFT WOOD

All soft wood shall consist of pines, spruce, hemlock and douglas fir or cedrous deodar (referred in the document as deodar), wood locally known as Deodar Wood.

11.3.3. PLY WOOD

The plywood of any type mentioned on drawings and Schedule of values (softwood plywood, hardwood plywood, marine plywood, etc) shall comply in all respects with BSI No. 1455:1963 approved by the Engineer. All plywood shall be manufactured with phenol pharamaldehyde or any other approved waterproof adhesive but not with urea pharamaldehyde.

Plywood used for doors, 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.

11.3.4. LAMINATED VENEERED BOARD

It shall be built-up board, with narrow strip 3 to 7 mm wide, faced both sides with either one or two veneers from 1.2 mm to 3.7 mm thick. Where single or double face veneers are used, the grain shall usually run at right angles to the grain of the core strip. This type of board, conforming to B.S. 3444 and of a thickness between 13 mm to 25 mm, shall be the base for the highest class of veneered wood.

11.3.5. CHIP BOARDS (PARTICLE BOARD)

Chip boards shall be made of wood particles in the form of chips or shavings of a controlled size combined with a thermo setting synthetic resin glue binder and formed into panels under the influence of mechanical pressure and heat. The process of adhesion shall be controlled resulting in a variety of boards with different but predictable physical properties. Chip Board, if specified, shall be used in sheathing, flooring and sub-flooring, wall paneling, partitions, shelves, furniture and veneered boards. It should not be affected dimensionally by changes in atmospheric humidity, though in wet conditions it shall have a limited resistance to moisture.

The surface finish of standard boards shall be comparatively rough and to support a good quality paint or varnish finish it shall require sanding and filling. Special grade of the board which has a paper surface permanently bonded to the board during manufacture shall be used for painting.

Chip boards shall be classified in grades of high, medium and low density mainly in thickness of 13 mm and 19 mm. The density range of this board is from 480 to 800 Kg per cubic meter as under:

High Density (HDF)	Above 800 kg/m³
Might (MDF)	Below 650 kg/m³
Ultra-Light (ULDF)	Below 550 kg/m³

Due to variation between brands, the weight of chipboard is not constantly proportional to thickness. Typical weights, based on standard chipboard with average density 750 kg/m³, are:

Thickness	Mass Per Unit Area
13.0mm	9 kg/m ²
16.0mm	11.0 kg/m ²
19.0 mm	14.0 kg/m ²

Chipboard is available in an extensive range of thicknesses, i.e. 1.8mm to 60mm. The most common sheet sizes are: widths 1220mm, 1525mm and 1850mm and in lengths upto 3660mm.

Medium density fiberboard to be used on the project shall be imported of Malaysian origin of thickness as specified in the drawings. Board shall be manufactured with waterproof resinous glues and shall be guaranteed by the manufacturer. All boards required for the exterior surfaces of cabinets shall be laminated with Formica in approved colour and texture in factory as specified elsewhere.

11.3.6. 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 fibre, 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 moisture content of timber shall not be more than 10 (ten) percent in case of soft wood and 7 (seven) percent in case of hard wood.

11.3.7. PRESERVATION OF WOOD

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

The preservatives shall be of the best available quality 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.

11.3.8. ADHESIVE

The adhesives shall conform to the requirements of BSI No. 745 manufactured approved for this Project or as directed and approved by the Engineer.

11.3.9. NAILS AND SCREWS

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

11.4. DELIVERY, STORAGE AND HANDLING

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

Keep products dry, stack products off ground on level platforms, fully protected from weather, including direct sun-light.

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

11.5. EXECUTION /FABRICATION

'Unwrought' timber shall be used. Sawing shall be done with sufficient oversize margin to finally meet the requirements of specified sizes and dimensions of the finished work.

All framing shall be joined and glued properly 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 mortizing, tenoning, grooving, matching, tangoing, 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.

11.6. PROTECTION OF MATERIALS

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

11.7. WOODEN DOORS**11.7.1. MATERIALS**

First class Deodar wood as approved by the Engineer shall be used for doorframes and frames of shutters as specified and shown on drawings. Deodar wood planks/MDF boards shall be used in paneled shutters. Deodar wood shall be used as inner core for flush doors with Ash Ply facing.

Architraves, beads, lippings shall be of Deodar /Ash Wood of specified sizes and fixed as per details shown on Drawings.

11.7.2. GROUND, BLOCKING & NAILING STRIPS

Ground, blocking and nailing strips shall be provided as necessary to receive the work included herein and as required for the work of other trades.

Except as otherwise shown or specified, ground blocking and nailing strips shall be secured in place as follows:

To steel--- by means of 3/8" diameter bolts spaced not over 3 feet.

To brick wall ---- by the use of cut nails spaced not more than 1.5 feet apart and driven directly into the block.

To poured concrete ---- by means of 1/4" diameter galvanized expansion bolts spaced not more than 1.5 feet part or by any approved method.

11.7.3. EXTERIOR AND INTERIOR DOOR FRAMES

All exposed surfaces of frames and architraves/beads shall be lacquer polished/painted with synthetic matt finished enamel paint of approved shade as per the instructions of the Engineer.

The doorframes shall be secured in place by means of corrugated anchors of non ferrous metal or galvanized ferrous metal bent up against the back and welded in place and built into masonry as it is being constructed. There shall be minimum of three anchors per side, with a maximum distance of three feet between the anchors. Additional steel plates for reinforcement shall be provided in the frame at the locations of hinges / locking arrangements.

11.7.4. DOOR SHUTTERS

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

All doors, shutters shall be fabricated in a workman like manner strictly to the correct sizes and shapes as shown on the Drawings or as directed by the Engineer. Flush shutters shall be hydraulically hot pressed and the frame of the shutter shall have tongue and grove joint.

The door shutters shall be built in sections, properly jointed and glued together. The surfaces shall be prepared for painting or polishing.

All door shutters shall be flush as per the schedule and details, fabricated from first class deodar wood as shown on drawings. Flush shutters wherever specified shall have Deodar / hard wood solid core with Polished Ash Ply of required thickness, color and approved quality on both sides.

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

Completed doors shall be sound, rigid and free from defects and warp. All edges shall be aligned and smooth, joints shall be close fitting, hard wood doweled 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 shall be flush and smooth. Edges shall be rectangular and solid.

All exposed surfaces of wooden frames and wooden shutters shall be lacquer polished/painted with synthetic matt finished enamel paint of approved shade as per the instructions of the Engineer.

Chamfers shall be made as shown on the drawings or as directed by the Engineer.

11.7.5. 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 1/8" at sides and top unless otherwise directed by the Engineer and shall have 3/16" 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 Engineer. Where directed by the Engineer margin for carpet shall be incorporated in the door shutter.

11.7.6. HARDWARE

Hardware shall be of best quality local make extra heavy duty and first class finished material except door locks and door closures which shall be imported of European origin as per attached hardware schedule. The CONTRACTOR shall obtain prior approval from the Engineer for quality, shape, pattern, and brand of all 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 and delivered to the Engineer.

11.8. QUALITY ASSURANCE

Tolerances: Doors shall be fabricated to following tolerances

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).

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

11.9. INSTALLATION

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

Install finish hardware in accordance with manufacturer directions.

11.10. PARTITIONS

Partitions wherever shown on the drawings will be fabricated from deodar wood inner frames, MDF boards, glazing, hollow flush shutters (at least 70 % solid with deodar wood frame and Deodar wood core). CONTRACTOR shall submit detailed shop drawing for the approval of the Engineer. The surface of partitions shall be prepared for painting.

11.11. DEFECTIVE WORK

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

11.12. SURFACE PREPARATION

The surfaces of all wood works shall be prepared in the manner as directed by the Engineer for polishing or painting. Lacquer Polish, French polish must be used for the finishing of the Wood Work.

12. SURFACE RENDERING AND CLADDING

12.1. 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 any floor and at any height connection with providing and installation of cement plaster, and specified external rendering complete in strict accordance with this section of the Specifications and the applicable drawings and subject to the terms and conditions of the Contract.

12.2. MATERIAL

12.2.1. Cement for plaster shall be Ordinary Portland Cement (B.S 12 or P.S 232) or ASTM C144-C631 CP 211 & CP 211 ASTM-D 596, C-40 C-87 C-109.

12.2.2. Sand for plaster shall comply with the requirements of BS 1199, BS 1200 or the draft Pakistan Standard "Sand for Plaster" as directed by the Engineer.

12.2.3. Water for plaster shall conform to requirements specified in the section for "plain and reinforced concrete".

12.2.4. Granite Slabs shall comply with ASTM C 615, "Standard Specification for Granite Dimension Stone" for material characteristics, physical requirements, and sampling for selection of granite and should be mechanically fixed as shown on the Drawings.

12.2.5. Sand Stone should be conforming to the drawings and manufacturer's data.

12.2.6. SKINROCK is a wall covering made of real natural stone and it should conform to ASTM C-121 standard. Stone is drawn onto a solid carrier film in thin layers. Even larger stone veneers in the sizes 120 x 60 cm and 250 x 120 cm are extremely lightweight and can be installed on almost any surface.

12.2.7. Color Crete includes Karachi Sand in any color with binding and water proofing chemicals. Consists of silica sand, white cement, binding chemical of pegal German color and yellow color from China.

12.2.8. All materials and workmanship for plaster, not explained in these Specifications, shall comply with the requirements of relevant BS CP 211 and CP 221 as directed by the Engineer. The material used for plastering and pointing shall be got tested by the ENGINEER at the expense of the CONTRACTOR before giving approval thereof and the same approved type of material shall be used throughout the work. Waterproofing agent of proper standard shall be used where specified or indicated.

12.3. SUBMITTALS

The material used for plastering and pointing shall be got tested by the ENGINEER at the expense of the CONTRACTOR before giving approval thereof and the same approved type of material shall be used throughout the work. Waterproofing agent of proper standard shall be used where specified or indicated.

12.4. EXECUTION

12.4.1. Except as may be otherwise shown on surfaces specified, all plaster work, both internal and external shall be ordinary Portland cement plaster of the required thickness as shown on the drawings.

12.4.2. Plastering shall not commence until all electric conduits, drainage and sanitary pipes, inlets to tanks, brackets, clamps, doors and window frames and all sorts of inserts and embedded items are fixed in position. It shall be the responsibility of the SUB-Contractor to make sure that all such work is carried out by other CONTRACTORS before starting of plaster work. Chiseling and repairing of cement plaster shall not be permitted without the approval of the Engineer. Sample of materials shall be submitted to the Engineer for his approval prior to use in the works.

12.5. PROPORTIONING AND MIXING

12.5.1. Measurement of materials by volume shall be by containers of known capacity to maintain consistent proportions. No lumpy or caked material shall be used. Mixing equipment boxes and tools shall be clean. Materials shall be proportioned as specified on the Drawings, in the Schedule of values or as directed by the Engineer. Mixing shall be continuous until all ingredients are evenly distributed and thoroughly mixed.

12.5.2. Only limited water shall be added for proper workability and such quantity of mortar shall be prepared which can be consumed in thirty minutes after preparation. Preparation of mortar in bulk quantity for use during the entire day or for any other time more than that stipulated above is expressly prohibited. Retempering shall not be permitted and all mortar which has begun to stiffen shall be discarded.

12.5.3. Plaster ingredients shall be thoroughly mixed either by hand on a clean cement concrete platform or by a mechanical mixer, as directed by the Engineer.

12.6. PREPARATION OF SURFACE TO BE PLASTERED

12.6.1. Concrete surface to be plastered shall be cleaned to remove all grease, form oil and other surface impurities, which will otherwise adversely affect the adhesion of plaster to the surface concerned. The surface of all-concrete ceilings, beams and

columns shall be lightly hacked by approved means to give the required key for plastering.

12.6.2. All masonry surfaces to be plastered shall be cleaned to remove all matter, which will otherwise adversely affect the adhesion of plaster to the surface concerned. The surface shall be washed with clean water and kept damp for 24 hours before further treatment. The surface thus prepared shall be treated uniformly with cement and sand slurry. The slurry to be used shall be one part cement to one part sand by volume with water added to make a stiff creamy mix. The slurry shall be applied with a stiff brush on surface, which has previously been well wetted. The surface so treated shall be left to cure for 3 days.

12.7. APPLICATION OF PLASTER

12.7.1. The plaster of thickness less than the specified thickness shall be rejected. If the plaster is to be more than 3/4" thick, it shall be done in two coats. The surface of first coat shall be made rough before the second coat is applied. Smooth surface of concrete cost-in-situ shall be made rough by chiseling gently.

12.7.2. The plaster shall not have wavy surface and shall be perfectly in plumb. The edges and corners shall represent a straight line. The plaster shall be kept wet continuously for at least ten (10) days. No extra payment shall be allowed for jambs, junctions, corners, edges, round surfaces or for more than one layer of plaster required due to any unevenness in the work done by the CONTRACTOR. The plasterwork is to cover all conduits, pipes etc. fixed in the walls and ceiling. Wherever specified, metal lath shall be nailed firmly before plastering is commenced. The plaster surface shall be tested frequently with a 10 feet straight edge and plumb bob.

12.7.3. Plaster containing cracks, blisters, pits, discoloration or any defects shall not be acceptable. Any such plaster or loose plaster shall be removed & replaced with plaster in conformity with these specifications and as additionally directed by the Engineer. CONTRACTOR shall cut out and patch all defective work at his own cost. All damaged plaster shall be patched as directed by the Engineer. Patching plaster shall match appearance of and shall be finished level with adjoining plaster.

12.8. METAL LATH

12.8.1. Metal lathing shall be fabricated from sheet steel and shall be of uniform quality and free from flaws broken strands, cracks and corrosive pitting, shall be rectangular and true to shape and shall comply with BS-1369.

12.8.2. All lathing shall be galvanized. Where plastering material depends entirely on the lathing for its key, these shall be not less than two complete mesh openings per 1-1/8" in one direction and the width of the aperture shall not be less than 3/16".

12.8.3. Sheets shall not be less than 1.6 kg/sq.m when fabricated, using 0.7 mm thick steel sheet. Where used on smooth surfaces to form a key it shall be not less than 1.2 kg/sq.m when fabricated, using 0.5 mm thick steel sheet. Tying wire shall be 1.2 mm diameter galvanized annealed iron wire. Sheets shall be welded to angle iron frame as shown on drawings or as per direction of incharge.

12.9. INTERNAL/EXTERNAL PLASTER

Where specified in the Drawings external surface shall have an average 3/4" thick plaster finish, consisting of a base coat of 1:4 cement sand mortar in Grey cement and the finish coat of smooth plaster as shown on the Drawings and as directed by the Engineer. Where specified in the Drawings all internal plaster shall have an average 1/2" thick consisting of base coat of 1:3/1:4 cement sand mortar in grey cement and finish coat of smooth plaster as shown on the Drawings and as directed by the Engineer.

12.10. CURING

Curing of base coats and finish coats of walls shall be by covering with burlap, kept wet at all times, shall commence as soon as plaster has set and shall continue for 8 days or as noted otherwise. Curing of ceilings: Shall be by direct application of water so as to keep plaster damp at all times for 8 days.

12.11. CLEANING AND PROTECTION

12.11.1. Rubbish and debris shall be removed as necessary to make way for work of other trades and as directed by the Engineer. As each room or space is completed all rubbish, debris, scaffolding and tools should be removed to leave the room clean.

12.11.2. Remove protective materials and any plaster materials from adjacent surfaces. Prior to plastering all aluminum windows, finished metals should be covered by sheet of plastic or tarpaulin to protect it from damage.

12.11.3. Protect finished plaster from injury by any source. CONTRACTOR shall also protect walls, floors and work of other trades from plaster materials.

13. WATER PROOFING

13.1. SCOPE

The work under this section of the Specifications consists of furnishing all plant, labor, equipment, appliances and materials and in performing all operations in any floor and at any height in connection with installation of insulation, water-proofing and built-up roofing, including water proof treatment to foundations and basement structures complete in strict accordance with the specifications and the applicable drawings.

13.2. SUBMITTAL

13.2.1. Shop drawings shall be submitted showing all the details for construction.

13.2.2. Installer Certificates: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install roofing system.

13.2.3. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements as specified.

13.2.4. Submit 2 samples of insulation and any other samples requested as per direction of Engineer

13.2.5. Product Data: Submit copies of manufacturer's product data sheets, installation instructions, use limitations and recommendations. Include certification of data indicating Volatile Organic Compound [VOC] content of all components of waterproofing system.

13.2.6. Installer Qualifications: Copies of verification of waterproofing capabilities, facilities, personnel and a list of completed projects comparable to scope of this project.

13.2.7. Samples of all materials proposed for use under this section, shall be submitted to the Engineer for approval.

13.3. MATERIALS

13.3.1. Bitumen shall be specified grade as per drawing and Special Industrial bitumen (SIB) National / Refinery. A priming coat of suitable thinned bitumen shall be applied before the application of bitumen coating.

13.3.2. Polyethylene building film Vis queen standard or approved equal. The film shall be 150 (minimum) micron thick.

13.3.3. For thermal insulation closed cell polyethylene foam bonded sheets manufactured by JUMBOLON shall be used. The thickness of bonded sheets shall be 1-½" minimum.

13.4. DELIVERY STORAGE AND HANDLING

13.4.1. Materials shall be protected from damage during loading shipment delivery and storage. Non-staining materials shall be used for blocking and packing.

13.4.2. Water proof membrane shall be stored at a temperature recommended by the manufacturer. Deliver materials to job site in labelled packages

13.4.3. Store and handle materials in strict compliance with manufacturer's instructions, recommendations, and material safety data sheets.

13.4.4. Protect materials from damage from sunlight, weather, excessive temperatures, and construction operations. Remove damaged material from the site and dispose of in accordance with applicable regulations.

13.4.5. Do not double-stack pallets of membrane on the job site. Provide cover on top and all sides, allowing for adequate ventilation.

13.4.6. Protect mastic and adhesive from moisture and potential source of ignition.

13.4.7. Store protection board flat and off ground. Provide cover on top and all sides.

13.4.8. Store aluminium materials clear of ground in a dry place. Protect from distortion, damage to surfaces & edges and from contact with alkaline materials.

13.5. EXECUTION

Inspect all surfaces to receive roofing materials, waterproofing, insulation & sheet metal and ascertain that they are sound, clean, smooth, dry and free of debris, loose material or defects which would have an adverse effect on the roofing application or performance. All vents and any other projections through the roofs shall be properly flashed and secured in position.

13.6. PREPARATORY WORK

All scuppers and roof drains shall be placed and metal flashing flanges etc. shall be provided in time to be installed along with the roofing assembly.

All surfaces, to be treated shall be dust free and dry. Application of roof finishes shall not start unless the preparatory work has been inspected and approved by the Engineer.

13.7. APPLICATION

13.7.1. Roofing shall not be applied during rain or while surfaces are damp, it shall be applied only to surfaces that are clean and dry.

13.7.2. The CONTRACTOR shall protect the sheets from damages during laying and subsequent operation and shall replace at his own cost all damaged sheets to the satisfaction of the Engineer.

13.7.3. For thermal insulation closed cell polyethylene foam bonded sheets manufactured by JUMBOLON shall be laid in places as designated on drawings or as directed by the Engineer. Joints between the sheets/overlaps shall be treated as per Manufacturer's recommendation.

13.7.4. Polyethylene sheet shall be laid in position wherever shown in drawings or specified herein. Where joint is necessary at the side or end of the sheet, this shall be a double weld folded joint made by placing the edges together and folding over twice continuously taking the top edge prior to the application of mud plaster. The SUB-Contractor shall protect the sheets from damages during laying and subsequent operation and shall replace at his own cost all damaged sheets to the satisfaction of the Engineer.

13.7.5. Brick tile of approved size shall be laid in 1:3, grouted and pointed flush in cement mortar. The top surface shall be smooth and accurately leveled in accordance with the specified slope. No broken or cracked tiles shall be used.

13.7.6. SETTING OUT: the area to receive tiles shall be set out to correct alignment, gradients and crossfall using optical instruments.

13.7.7. LAYING: each tile or paver shall be laid as indicated in drawings, depths as specified or detailed. All adjacent vertical edges shall be mortared. Before each tile is fixed to a slight concave bevel, check to insure correct alignment with adjacent tiles or pavers and that there is no evidence of rocking or movement. Fill joints as soon as possible after tile or paver installation.

13.7.8. CUTTING OF TILES: make all cuts square to the face of the flag. A tolerance of 1/8" shall be permitted where such cuts abut other tiles or pavers or fittings in the area of work. Cut tiles occurring on curves to radius lines.

13.7.9. SURFACE ACCURACY: a tolerance of 1/8" over 10 feet shall be permitted, alignment of tiles with adjacent edging, curbs, etc. shall be as detailed. Chipped, broken and cracked tiles will be rejected.

13.7.10. CURING: Tiles after laying, grouting and flush pointing shall be kept wet throughout for at least 7 days.

14. FALSE CEILING

14.1. SCOPE

The work under this section of the specifications, consists of furnishing all plant, labour, equipment, appliances and materials in any floor and at any height and in performing all operations in connection with providing and installing different types of false ceiling including suspension system complete, in strict accordance with this section of the specifications and the applicable drawings and subject to the terms and conditions of the Contract.

14.2. SUBMITTALS

14.2.1. Shop drawings shall be submitted showing reflected ceiling plan, locations of built in products and access facilities, dimensions, layout arrangements, hanger locations, structural connection, details of level changes, direction of pattern and panel joint details: The shop drawings shall be got approved by the CONTRACTOR from the Engineer in advance of under taking this item of works.

14.2.2. No materials shall be procured prior to approval of shop drawings and details.

14.2.3. The CONTRACTOR shall incorporate the required access panels of false ceiling as per approved shop drawings.

14.3. MATERIALS

14.3.1. WATER RESISTANT GYPSUM BOARD CEILING

- ASTM C1396 (Section 7), regular type except where Type X fire-resistant type is indicated or required to meet UL assembly types.
- Thickness: 1/2 inch, unless otherwise indicated.
- Acceptable products: Equivalent to Sheetrock Brand Water-resistant, Water-resistant Firecode "C" or Water-resistant Firecode Type X Gypsum Panels by USG.

14.3.2. GYPSUM BOARD CEILING

- ASTM C1396 (Section 5), regular type [except where Type X fire-resistant type is indicated or required to meet UL assembly types.
- Thickness: 1/2 inch, unless otherwise indicated

14.3.3. Plastic of Paris

For materials and standards in Plastic of Paris ceiling refer to MES 2014 Ref No. 14-29

14.3.4. SUSPENSION SYSTEM

The suspension system for all types of false ceiling shall be in accordance with the recommendations of the approved false ceiling manufacturer and approved shop drawings, galvanized steel universal U-channels/ main T/Cross-T Bars, wail moldings/ edge trims, hold down/adjustment clips, galvanized, hanger strips with adjustment mechanism, etc. Main-T/Cross-T bars shall have the exposed surface finished in the desired colour as per the instructions of the Engineer.

14.4. DELIVERY, STORAGE AND HANDLING

14.4.1. Material shall be delivered in original, unopened, protective packaging, with manufacturer's labels indicating brand name, pattern, size, thickness and fire rating.

14.4.2. Material shall be stored in original protective packaging to prevent soiling, physical damage or wetting.

14.4.3. Cartons shall be stored in the installation area, opened at each end to stabilize moisture content and temperature, for 48 hours prior to installation.

14.5. EXECUTION

False ceiling shall be installed wherever indicated on the drawings by skilled technicians experienced in this type of work. Installation shall not commence in any room or space before completion of plaster work on structural roofing/internal walling/external surfaces.

14.5.1. JOB SITE CONDITIONS

14.5.1.1. Work, which will be concealed by false ceilings, shall be completed, tested, inspected and accepted before ceiling work is started.

False ceiling installation shall not begin until the area has been closed in, and temperature and humidity approximate occupancy conditions. Wet work shall be cured and dry before ceiling work is started.

14.5.1.2. Surface which will support the ceilings, and those to which the ceiling abut, shall be inspected and accepted for completeness and adequacy to receive the ceilings before the work begins.

14.5.2. INSTALLATION AND WORKMANSHIP

False ceiling suspension system and panels shall be installed in accordance with the manufacturer's recommendations and as approved by the Engineer.

14.5.2.1. Suspension System

The hangers as specified shall be evenly disposed as per drawings, details and place and position as indicated. The suspension system should be installed by making holes directly in the roof and shall be made good as directed by the Engineer. Their lengths clear of roofing slab shall be as per shop drawing details.

The framing of the specified sections, jointing of runners to hangers, extra framing where required shall be provided for light receptacles as per approved shop drawing details.

Wall hangers shall be positively and rigidly connected to the structure and to cross runners.

14.5.2.2. Gypsum Board Tiles/Moisture-Resistant Gypsum Board/Echo Bloc Gypsum Board false ceiling.

Panels shall be installed in the grid system after completion of installation of the suspension of lighting and air conditioning fixtures.

Forming ceiling panels shall be laid out in pattern including border of uniform width around all sides of each ceiling area. The pattern shall be as per shop drawings approved by the Engineer.

All panels shall be furnished and installed in an approved manner and as per approved types, sizes and surface design.

14.5.3. INSTALLATION OF FIXTURES

Light fixtures shall be installed as per approved pattern and supported in accordance with manufacturer's recommendations.

14.5.4. FINISHING

After installation, dirty, oiled or discolored surfaces shall be cleaned and left free from defects and ready to receive any painted finish if required.

The panels, which are damaged or improperly installed, shall be removed and replaced by the CONTRACTOR at his cost.

15. PAINTING & VARNISHING

15.1. SCOPE

The work under this section of the Specifications consists of furnishing all materials, plant, labor, equipment, appliances and performing all operations in any floor and at any height in connection with surface preparation, mixing, painting concrete works, gates, frames, walls, ceilings and all such surfaces, architectural textured coatings, as shown on the Drawings and/or as directed by the Engineer. The scope of this section of specification is covered with detailed specifications as laid down herein.

15.2. SUBMITTALS

Samples of all colors/textures and finishes shall be prepared in advance of requirement so as not to delay work and shall be submitted to the Engineer for approval before any work is commenced. Any work done without such approval shall be redone to the Engineer's satisfaction, without additional expense to the ENGINEER. Samples of each type of paint/textured coating shall be on separate 12" x 12" x 1/8" tempered hard board panels. Manufacturer's chart showing all the variety of paint/textures shall be submitted for color/texture selection.

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

15.3. MATERIALS

15.3.1. Except as otherwise specified, all painting shall be applied in conformity with BS CP 231 "Painting of Building" as applicable to the work. All materials shall be acceptable, proven, first grade products and shall meet or exceed the minimum standards of reputable manufacturers as approved by the Engineer.

15.3.2. Colors shall be pure, non-fading pigments, mildew-proof sun-proof, finely ground in approved medium. Colors used on-plaster and concrete surfaces shall be lime-proof. All materials shall be subject to the Engineer's approval.

15.3.3. All synthetic enamel paints and primers for structural steel works, metal work and wood works will be the best available of its type and shall be approved by the Engineer prior to its procurement.

15.3.4. Approved quality Weather Shield/Weather Coat paint shall be used for painting the exteriors of the structures or other surfaces where specified on the drawings as directed by the Engineer.

15.3.5. The plastic emulsion paint/vinyl emulsion paint or similar as approved by the Engineer shall be used for interior surfaces.

15.3.6. Texture coating wherever specified shall be acrylic resin based coating composed of acrylic copolymers, natural quartz, natural marble chips, metallic oxides, antibacterial and antifungal additives, and expanders, foaming and setting agents and shall be applied in accordance with approved manufacturer's recommendations.

15.3.7. All material for Bitumen painting shall consist of Bitumen grade as mentioned on drawings. It shall be used for foundations or wherever recommended by the Engineer. The rate of application in foundations shall not be less than 20 lb/100 Sft. each coat.

15.4. DELIVERY, STORAGE AND HANDLING

Paints/coatings shall be delivered to the site in sealed containers, which plainly show the type of paint, colour (formula or specifications number) batch number, texture, quantity, date of manufacture, name of manufacturer and instructions 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 Engineer. If storage is allowed inside the building, floors shall be kept clean and free from paint spillage.

15.5. EXECUTION

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

SURFACE PREPARATION

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

15.5.2. In the event the surfaces become otherwise contaminated in the interval between cleaning and painting/coating, re-cleaning will be done by the CONTRACTOR at no additional cost.

15.5.3. Surfaces of stainless steel, aluminum, bronze, and machined surfaces adjacent to metal work being cleaned or painted shall be protected by effective masking or other suitable means, during the cleaning and painting operations.

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

15.5.5. All surfaces to be bitumen painted shall be thoroughly cleaned of any accretion, dust, dirt etc. by scraping, wire-brushing or as directed by the Engineer. The surface shall be primed with a coat of asphalt oil used at the rate of not less than 1 gallon per 100 square foot of area. No work in this section shall be allowed until all surfaces or conditions have been inspected and approved by the Engineer.

15.6. APPLICATION

15.6.1. 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 paints shall be applied under dry and dust free conditions. Unless approved by the Engineer 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.

15.6.2. All primary paint 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.

15.6.3. 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.

15.6.4. Coats of Weather Shield/Weather Coat paint and textured coatings shall be applied in accordance with the manufacturer's instructions or as directed by the Engineer.

15.6.5. For painting only as much 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.

15.6.6. Where shown on Drawings all exterior finishes shall be painted/coated with Weather Shield/weather coat paint or texture coated in approved colours/textures as per manufacturer's specifications. The number of coats shall be as shown on the drawings or as directed by the Engineer.

15.6.7. All wooden doors shall be painted with approved synthetic enamel paint or lacquer polished as per manufacturer's recommendation and instructions or after approval of the Engineer.

15.6.8. Plastic emulsion paint, vinyl emulsion paint or matt enamel paint of the approved make and shade shall be applied to surfaces as shown on Drawings as per manufacturer's instructions. The number of coat shall be as indicated on the Drawings or as directed by the Engineer.

15.6.9. Two coats of hot bitumen paint shall be applied to exposed concrete surfaces in contact with earth. The first coat shall be allowed to dry for about six hours before applying the second coat. During the operation of painting great care should be taken to avoid air bubbles. The manufacturer's instructions and Engineer's directions shall be complied with.

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

15.7. JOB CONDITIONS

15.7.1. 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 and less than 43 degree C. No painting shall be done above 90% relative humidity.

15.7.2. Place drop cloths to adequately protect all finished work.

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

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

15.8. QUALITY ASSURANCE

All paint/coat for any one surface shall be top quality, of one manufacturer and approved by the Engineer. 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.

16. STEEL AND METAL WORKS

16.1. 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.

16.2. APPLICABLE STANDARDS

Latest edition of the following standards are relevant to these specifications wherever applicable:

AISC Code of standard practice

AISC Specifications for Design, Fabrication and Erection of Structural Steel for buildings.

AISC Specifications for structural joints using ASTM A325 or A490 Bolts.

ASTM Specifications for materials

AISC/ Guide to shop painting of structural steel

AWS Specifications for welding of steel structures

BS 449 Use of structural steel in Buildings

16.3. SUBMITTALS

Shop drawings shall be prepared by the CONTRACTOR. These shall contain main dimensions, sizes of members, typical details of joints and submitted to the Engineer for approval.

16.4. 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.

16.4.1. MILD STEEL

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

16.4.2. STEEL FORGING

Steel forging shall conform to the requirements of ASTM A235.

16.4.3. STAINLESS STEEL

Stainless Steel shall conform to the requirements of AISI 304 or 316.

16.4.4. PIPE FOR HANDRAILS

Pipe for hand rails: unless shown otherwise on drawings, it shall conform to Stainless Steel standards mentioned above.

16.4.5. CORRUGATED GI SHEETS

Pipe for hand rails: unless shown otherwise on drawings, it shall be medium grade complying with the requirements of ASTM A-123, A-153, A-767.

16.4.6. STEEL CASTING

Steel casting shall conform to the requirements of ASTM A27.

16.4.7. 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.

16.4.8. COMMON BOLTS, ANCHOR BOLTS, NUTS AND WASHERS

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

16.4.9. 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

16.4.10. 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.

16.4.11. CAST IRON

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

16.5. CONNECTIONS

16.5.1. DESIGN OF CONNECTION

All connections shall be designed and detailed for forces shown on the drawings, if any or 50% of the effective capacity of the member, whichever is greater.

Shop connections may be welded or bolted. Field connections shall be bolted unless noted otherwise on design drawings.

16.5.2. INSTALLATION OF BOLTS

High strength bolts shall be installed in accordance with AISC "Specifications for Structural Joints using ASTM A 325 or A 490 bolts".

16.5.3. MINIMUM SPACING OF BOLTS

The distance between centers of boltholes shall not be less than $3d$, where d is the diameter of the bolt in inches.

16.5.4. MINIMUM EDGE DISTANCE

The minimum edge distance i.e. center of standard hole to edge of connected part shall be as given in the table below:

NOMONAL BOLT DIAMETER (INCHES)	AT SHEARED EDGES (INCHES)	AT ROLLED EDGES OR PLATES, SHAPES OR GAS CUT EDGES (INCHES)
<hr/>		
1 / 2		3 / 4
5 / 8		7 / 8
3 / 4	1.5 TIMES THE DIAMETER OF BOLTS	1
7 / 8		1 – 1 / 8
1		1 – 1 / 4

16.5.5. ALLOWABLE STRESSES

Allowable design stresses for structural steel members and their connections, including temporary bracings and shorings shall be in accordance with AISC Specifications.

16.6. EXECUTION

16.6.1. 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.

16.6.1.A. 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.

16.6.1.B. 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.

16.6.1.C. Holes Punching Drilling.

Holes shall be punched where thickness of the material is not greater than the diameter of bolt + 1/8". 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 1/16" smaller than the nominal diameter of the rivet or bolt. Holes for A514 steel plates over 1/2" thick shall be drilled.

16.6.1.D. Welding

a) 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.

b) Automatic sub-merged Arc Welding:

For all built-up members, i.e. 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.

c) 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.

d) Tolerances

- i. A variation of 1 mm is permissible in the overall length of members with both ends finished for Contact bearing. The bearing surfaces prepared to a common plane by milling.
- ii. 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 1/8" for length over 30 feet and not greater than 1/16" for length.
- iii. Members with ends finished for contact bearing shall have a variation 1/32" in the overall length.

16.6.2. TEST ASSEMBLY

16.6.2.A. After fabrication and before galvanization or painting, test assembly of complete Structural Components shall be done on the shop floor as directed by the Engineer.

16.6.2.B. Each test assembly will be inspected by the Engineer and will be dismantled only after his approval in writing

16.6.3. SURFACE PREPARATION/PAINTING

16.6.3.A. 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.

16.6.3.B. 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 and the thickness of the paint shall be in accordance with the specifications of the paint manufacturer.
- 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
- h. 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.

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. Unassembled pins, keys, and bolt thread shall be greased and wrapped with moisture resistant paper.

Contact surfaces of connections using high strength bolts in friction type connections shall not be painted. Such surfaces of all components after fabrication shall be cleaned free of all paints, grease, burrs slag by means of sand blasting. No coating whatsoever shall be applied to these surfaces. The surface roughness for high strength friction grip bolts is a very important factor and the components therefore will not be erected unless approved by the Engineer.

16.6.4. ERECTION

16.6.4.A. Bracing

The structure shall be carried up true and plumb within the limits defined in the AISC code of standard practice. Temporary bracing shall be introduced wherever necessary to take care of all loads of which the structure may be subjected including the equipment and the operation of the same. Such bracings shall be left in place as long as required for safety.

16.6.4.B. Alignment

Bolts tightening as specified by ASTM A 325 shall not be done at site during erection until the structure has been fully aligned and leveled.

16.6.4.C. Joints using High Strength Bolts

All structural joints using high strength bolts shall be executed and inspected in accordance with "AISC Specification for structural joints using ASTM A 325 or A 490 bolts".

16.6.4.D. Stubs

Stubs of trusses before being embedded in concrete shall be erected in position timely aligned using stub setting templates.

16.7. INSPECTION AND TESTS

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

16.7.1.B. 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. The CONTRACTOR shall check these before being worked upon and these shall be rejected if found not within limits.

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

16.7.1.D. Inspection of Welding.

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

16.7.1.E. 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.

16.8. MISCELLANEOUS STEEL WORKS

16.8.1.A. General

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

- a. Steel gates
- b. Steel grills
- c. Steel embedded plates anchor bolts and other miscellaneous items

The CONTRACTOR shall submit shop drawings for each item showing in sufficient detail the material, its fabrication, surface preparation and other relevant information so as to conform to the applicable requirements of relevant clauses of these specifications for Engineers Approval. After the approval of drawing the CONTRACTOR shall erect a mock-up sample showing exactly the finished item as it will be fabricated/erected. Only after the approval of the mock-up sample the CONTRACTOR shall start the fabrication of items to be installed in place. Any proposed deviation due to field conditions and availability of local material shall be submitted to the Engineer for approval.

17. ALUMINIUM WORKS

17.1. SCOPE

The work covered under this section of the specifications consists of providing all material, labor, equipment, performing all operations required for providing and installation of aluminum doors, windows, ventilators & louvers including all related items such as sealants, gasket, netting, rollers, hinges, latches, fastenings, anchor bolts, door locks, locking devices and glass complete in strict accordance with this section of specifications, the applicable drawings and as scheduled.

17.2. APPLICABLE STANDARDS

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

17.2.1. ISO (International Organization for Standardization)

1804	Doors	-	Terminology
6442	Door Leaves	-	Measurement of defects of General flatness.
6443	Door Leaves	-	Measurement of dimensions and Defects of squareness.
6444	Door Leaves	-	Test of behavior under humidity variations (successive uniform climates)
6612	Windows & Doors	-	wind resistance tests.
6613	Windows & Door	-	Air permeability test.

BSI (British Standard Institution)

1227	Hinges
4873	Aluminum alloy windows.

17.3. GENERAL

17.3.1. Door, Windows, ventilators, louvers and other items to be provided shall be aluminum, of profile pattern and design shown on drawings and shop drawings manufactured by reputable manufacturer approved by the Engineer. The contractor

shall provide manufacture literature completely describing the product instructions for installation and maintenance.

17.3.2. All the sections used for doors, windows, ventilators & louvers fly screens shall be of best quality aluminum products such as equal and unequal angles, channels, tubes, corrugated strips, moldings etc., in accordance with International standards conforming to ASTM B 308 & B 221.

17.3.3. All doors, windows. Ventilators and louvers shall be of type and size indicated on drawings and shall conform to the requirements shown and specified herein.

17.3.4. Contractor shall arrange tests and analysis if directed by the Engineer of scaled models of each door, window, ventilator and louvers type at the maker's works or any laboratory specified by the Engineer for the material supplied by him to be tested in the presence of the Engineer's Inspector, to whom test certificates, proof sheets, etc. shall be furnished. The models shall be submitted to the Engineer for approval prior to testing. Nevertheless, neither the fact that the materials have been tested in the presence of the inspector nor that the Engineer may have been furnished with test certificates in lieu of sending an inspector to the works shall affect the liberty of the Engineer to reject, after delivery of materials found not in accordance with these specifications.

17.3.5. The contractor shall submit shop drawings conforming to design concept which shall show full construction details, quantities and locations, fastenings, stiffening members and attachments to adjacent construction and materials. Shop drawings and calculations shall be submitted at the proper time to allow for checking, revisions, and agreement and to permit manufacturer's product delivery and start of site work to suit the building programme. The Contractor shall submit representative samples of finished doors, windows, anchoring mechanism, embedded parts, fastenings, glass panes, accessories and other materials for the Engineer's approval.

After approval of shop drawings and tests etc., the Contractor shall submit at his own cost one mock-up sample of each type of aluminum works complete with glazing, all components assembly method and required fittings and 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.

Fabricate and assemble all work in the shop of the approved manufacturer to reduce field fabrication to a minimum unless otherwise directed by the Engineer.

17.3.6. The glass shall conform to specification laid down under chapter 'Glazing' and shall be free from all blemishes, bubbles, distortions and other flaws of any kind and shall be properly cut to size as shown on drawings, so as to fit the grooves in window

members. Double glazed windows/ curtain wall shall have a gap of 12mm and sealed with European butyl and Argon gas filled by imported plant.

The tempering of glass should be done on European, USA or Japan origin plant. Tempered glass delivered at site should fulfill the requirements of International standards including ASTM, ANSI, BS, EN, JIS R 3206. It should have minimum 50 fragments in 50 mm x 50mm size when broken.

Maximum tolerance for roller wave is 0.13 mm and roller circumference should not be less than 300 mm. Glass bow/ bend should be less than 0.003mm/mm at long side & diagonal of glass.

17.3.7. The structural shape of the Aluminum members shall be of uniform quality, color and temper, clean, round, commercially straight and free from injurious defects.

17.3.8. All doors, windows, ventilators and louvers shall be fabricated as a complete unit, fully airtight and watertight, including rubber gasket for glazing, hinges, stays, rollers, latch, locking arrangement, handles, etc anodized/ powder coated in specified color, inclusive of glass sheet, necessary holes for fixing, door locks, door closures and window locking requirements, all as approved by the engineer.

17.3.9. Contractor shall, provide certificate signed by the manufacturer stating that each lot has been sampled, tested and inspected and has met the requirements in accordance with these specifications and the same shall be furnished to the Engineer.

17.3.10. The shop drawings shall clearly show that there shall be no penetration of rainwater from the exterior to the interior in case of severe wind and rainstorm. This has to be specially ensured in cill section.

17.4. MATERIAL

17.4.1. Frames/shutters

The frames of aluminum door, windows and ventilator shall be formed from rolled, strip or extruded aluminum. The thickness of sectional members shall be maximum 2.0 mm. All outer / frame sections of openable / fixed windows. Ventilators and louvers shall be 4" (100 mm) minimum in width. The Frames for doors and door/windows shall be at least 4" (100 mm) in width.

17.4.2. As shown on the drawings, aluminum frames shall be provided as per international standard approved by the engineer.

17.4.3. Fasteners shall be stainless steel of a type selected to prevent galvanic action with the components fastened.

17.4.4. Gaskets shall be vinyl glazing channel gasket to commercial standard CS-230-60.

17.4.5. Hardware shall be manufacturer's standard hardware. Flush to match doors, windows, ventilators and louvers finish. Floor mounted concealed type double action/swing imported door closures shall be provided to all doors. Heavy duty in-matching finish stays shall be provided to all openable windows, ventilators and louvers. Stays shall be attached to the window frame so as could be replaced easily.

17.4.6. Joint sealant shall be approved elastomer.

17.4.7. Aluminum sections shall be powder coated (where required) in accordance with the standards of Aluminum Association of USA where ever. The thickness of powder coating surface shall be of not less than 70-90 microns. The surface shall be properly sealed.

17.4.8. For powder coated finish aluminum sections to be coated shall be mill finish. The sections shall be firstly degreased with a degreasing chemical to remove all/any stains. The sections will then be given a chromating coating and electro static powder coating in the desired color with a powder-coating machine. After color coating the sections will be baked at baking temperature of 220 degree Centigrade for 25 minutes.

17.4.9. All sliding/openable windows shall have sliding/openable wire/fly screen shutters in window matching finish with wire/fly screen of size so as not to permit the entry of flies and mosquitoes. The wire mesh shall be 30 SWG. 14 mesh (14 x 14 openings per square inch).

17.5. DESIGN REQUIREMENT

The Contractor shall design the installation to meet or excell the following requirements.

17.5.1. Tolerances

The Contractor shall be responsible for agreeing to all dimensions with the Engineer before proceeding with the manufacture and for making provision to allow for building tolerances required by the Engineer. Contractor shall also take site measurements of the structure completed before manufacturing.

17.5.2. Thermal & Seismic Movements

The window and glazing assemblies are to be constructed and installed in the openings with sufficient tolerance and, where necessary, to provide for joints incorporated

in couplings, to provide for expansion and contraction as will be caused by the local seismic and climatic conditions and temperature changes, winter to summer - day to night without buckling, distortion of joints, or other harmful effects.

17.6. WORKMANSHIP

The Contractor shall be responsible for the protection and installation of all items furnished. All items shall be installed plumb and square and shall be solidly anchored in a good workman like manner in accordance with the manufacturer's instruction and as specified herein. The Contractor shall be responsible for the protection of installed items from damage by other trades. All items shall be left in operating, neat and clean condition, free from dirt, finger marks, etc. The Contractor shall be responsible for final cleaning before the final acceptance.

The glass panes shall firmly be secured in the rebates with the rubber gasket. Ensure that the beads and grooves are clean, dry and unobstructed at the time of glazing. The complete unit shall be airtight and watertight on completion. No doors, windows and ventilator shall be considered complete until and unless the fingerprints and other stains and marks have been removed from the surface of glass and aluminum.

17.7. PRODUCT DELIVERY AND STORAGE

17.7.1. Deliver doors, windows, ventilator and louvers in a manner preventing damage to units. Store materials off the ground under cover in a manner preventing deterioration or damage.

17.7.2. All embedded parts and anchor bolts shall be delivered to the site carefully and keeping the fabricated shape and configuration. All these parts shall be suitably marked for identification.

17.8. ERECTION

Rawal plugs and anchoring bolts shall be embedded into the concrete or block masonry for holding the doors windows, ventilators and louvers in their correct positions.

Care shall be taken to install the doors, windows, ventilators and louvers in line and plumb & solidly anchored in a good workman like manner in accordance with the drawings. Should any scale or scratch appears on the surface of doors, windows and ventilators the contractor shall at his own expense and at the Engineer's direction have all exposed surfaces cleaned to bare bright specified color.

All works shall be installed in strict accordance with the manufacturer's printed instructions.

17.9. 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 of items.

Damage to existing works from scaffolding or from any other object shall be repaired by the Contractor at his own cost.

17.10. PROTECTION AND CLEANING

17.10.1. Temporary protection shall be achieved by applying water-soluble protective coating capable of withstanding the action of lime mortar.

17.10.2. Apply coating in the manufacturer's plant to the exposed surfaces of all components.

17.10.3. Before application of coating, remove all fabrication compounds, moisture and dirt accumulations.

17.11. DEFECTIVE WORK

In the event of non-conformance to specifications and drawings the aluminum works shall be rejected by the Engineer and the Contractor shall remove and replace the rejected works by new work of same specifications.

17.12. GUARANTEE

17.12.1. The manufacturer shall furnish his standard written guarantee against leakage of rain, excessive infiltration of dust and air and all defects in materials and workmanship covering all work under this section. No payment shall be made for any arrangement required to be provided in the sections for complete protection against water leakage any damages caused to the furniture & furnishings, plant and equipment due to leakage of water shall be fully recovered from the Contractor.

17.12.2. Such guarantee shall be in addition to and not in lieu of all other liabilities which manufacturers and the Contractor may have by law or by other provisions of the Contract Documents.

18. TUFF PAVERS

18.1. SCOPE

The work under this section of the specifications consists of furnishing all plant, labor, equipment, all materials and performing all operations such as compaction of made up ground level (MUGL) in conformity with lines, grade, spreading, watering and compaction of sand and laying of Tuff Pavers, curing etc including supply from manufacturer and transportation to the site of works.

18.2. MATERIAL

Concrete Pavers: Solid, interlocking paving units, ASTM C 936, made from normal-weight aggregates in sizes and shapes indicated.

18.2.1. Coarse Aggregate: Clean, hard, un-weathered stone crushed into angular particles varying in size up to 3/8 inch (9.5 mm).

18.2.2. Filler: Dust produced from limestone or other material as standard with manufacturer.

18.2.3. Dimensional Tolerances: Manufacture unit to standard dimensions indicated with deviations in any dimension not exceeding plus or minus 1/16 inch (1.6 mm) by Owner with ground tudor finish.

18.2.4. 50mm thick concrete pavers must have minimum 28 days compressive strength of 5000 Psi whereas 60mm thick concrete pavers must have minimum 28 days compressive strength of 7000 Psi.

18.3. ACCESSORIES

Steel Edge Restraints: Painted commercial steel edging with loops pressed from or welded to face of sections at 36 inches (900 mm) o.c. to receive stakes, and steel stakes 15 inches (380 mm) long for each loop. Size of edging as follows:

- 3/16 inch (4.8 mm) thick by 4 inches (100 mm) high.
- 1/4" inch (6.4 mm) thick by 5 inches (125 mm) high.

Joint Filler Materials: Portland cement, ASTM C 150, Type I; and sand, ASTM C 144.

18.4. EXECUTION

Examine surfaces indicated to receive paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of unit pavers. Do not proceed with installation until unsatisfactory conditions have been corrected.

18.5. PREPARATION

Clean surface free of dirt, dust, debris, and loose particles.

18.6. INSTALLATION, GENERAL

Do not use unit pavers with chips, cracks, voids, discolorations, and other defects which are visible to the eye 6 feet away from the surface or could cause staining in finished work.

Mix pavers from several pallets or cubes as they are placed to produce uniform blend of colors and textures.

Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, Un-chipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable. Cut pavers are to be no smaller than 3 inches in any dimension where field cutting would result in pavers below these minimum sizes, use larger pavers adjacent to fill space.

- Joint Pattern: Match field-constructed mockup.
- Joint Pattern: As indicated on drawings.

18.6.1. Tolerances: Do not exceed 1/32-inch (0.8mm) unit-to-unit offset from flush (lippage) or 1/8 inch in 10 feet (3 mm in 3 m) from level, or indicated slope, for finished surface of paving.

18.6.2. Tolerances: Do not exceed 1/16-inch (1.5-mm) unit-to-unit offset from flush (lippage) or 1/8 inch in 24 inches (3 mm in 600 mm) and 1/4 inch in 10 feet (6 mm in 3 m) from level, or indicated slope, for finished surface of paving.

19. LANDSCAPE WORK

19.1. GENERAL

19.1.1. DESCRIPTION

These general requirements apply to all landscape operations. Refer to specification sections for specific general, product, and execution requirements.

19.1.2. QUALITY ASSURANCE

A. Comply with all applicable local and state requirements regarding materials, methods of work, and disposal of excess and waste materials.

B. Obtain and pay for all required inspections, permits, and fees. Provide notices required by governmental authorities.

C. Owner shall appoint a qualified representative to oversee the work and assure its adherence to the plans and these specifications. Henceforth, this person shall be designated as Owner's Representative.

19.1.3. PROJECT CONDITIONS

A. Locate and identify existing underground and overhead services and utilities within contract limit work areas. Provide adequate means of protection of utilities and services designated to remain. Repair utilities damaged during site work operations at Contractor's expense.

B. When uncharted or incorrectly charted underground piping or other utilities and services are encountered during site work operations, notify the applicable utility company immediately to obtain procedure directions. Cooperate with the applicable utility company in maintaining active services in operation.

C. Locate, protect, and maintain benchmarks, monuments, control points and project engineering reference points. Re-establish disturbed or destroyed items at Contractor's expense.

D. Obtain governing authorities written permission when required to close or obstruct street, walks and adjacent facilities. Provide alternate routes around closed or obstructed traffic ways when required by governing authorities.

E. Control dust caused by the work. Dampen surfaces as required. Comply with pollution control regulations of governing authorities.

F. Protect existing buildings, paving, and other services or facilities on site and adjacent to the site from damage caused by work operations. Cost of repair and restoration of damaged items at Contractor's expense.

G. Protect and maintain streetlights, utility poles and services, traffic signal control boxes, curb boxes, valves and other services, except items designated for removal. Remove or coordinate the removal of traffic signs, parking meters and postal mailboxes with the applicable governmental agency.

19.2. MATERIALS AND EQUIPMENT

A. Materials and equipment: As selected by Contractor, except as indicated.

19.3. EXECUTION

19.3.1. PREPARATION

A. Examine the areas and conditions under which work is to be performed. Do not proceed with the work until unsatisfactory conditions are corrected.

B. Consult the available records and drawings of adjacent work and of existing services and utilities which may affect work operations, as provided by owner.

19.4. TREES, PLANTS, AND GROUND COVERS

19.4.1. DESCRIPTION

A. Provide trees, plants, and ground covers as shown and specified. The work includes:

1. Soil preparation.
2. Trees, plants, and ground covers.
3. Planting mixes.
4. Mulch and planting accessories.
5. Existing plant relocation.

B. Related work:

1. Section 02200: Earthwork.
2. Section 02485: Seeding.

3. Section 02487: Sodding.

19.4.2. QUALITY ASSURANCE

A. Comply with GENERAL requirements.

B. Plant names indicated, should comply with “Standardized Plant Names” as adopted by the latest edition of the American Joint Committee of Horticultural Nomenclature or local recognized authority. Provide stock true to botanical name. Do not substitute without permission of owner or owners representative.

C. Comply with sizing and grading standards of the latest edition of “American Standard for Nursery Stock” or local recognized authority. A plant shall be dimensioned as it stands in its natural position.

For plant material grown in fabric-ground containers, the following chart shall determine root mass size in relation to caliper:

Fabric-ground Suggested Container Diameter Caliper of Size Plant

10"	1"
12"	1"
14" - 16"	1 ½" - 2"
18" - 20"	2" - 3"
22" - 24"	3" - 4"

D. All plants shall be nursery grown under climatic conditions similar to those in the locality of the project.

E. Stock furnished shall be at least the minimum size indicated. Larger stock is acceptable, at no additional cost to owner. Root systems must meet AAN standards as specified. Plants should not be altered by pruning or other means to meet specifications.

F. Provide “specimen” plants with a special height, shape or character of growth. Specimen trees or shrubs may be tagged at the source of supply. The Owner’s Representative may inspect specimen selections at the source of supply for suitability and adaptability to selected location. When specimen plants cannot be purchased locally, provide sufficient photographs of the proposed specimen plants for approval.

G. Plants may be inspected and approved at the place of growth, for compliance with specification requirements for quality, size and variety.

19.4.3. SUBMITTALS

A. Submit the following material samples, if requested:

1. Mulch -Bulk or Bagged.
2. Decorative Stone or Gravel -Bag or Bulk

B. Submit the following materials certification, if requested:

1. Topsoil source and pH value.
2. Peat moss, compost, or other organic soil amendments
3. Plant fertilizer.

19.4.4. DELIVERY, STORAGE, AND HANDLING

A. Deliver fertilizer materials in original, unopened and undamaged containers showing weight, analysis, and name of manufacturer. Store in manner to prevent wetting and deterioration.

B. Take all precautions customary in good nursery practice to prepare plants for transport. Workmanship, which fails to meet the highest standards, will be rejected. Spray deciduous plants in foliage with an approved Anti- Desiccant immediately before digging to prevent dehydration. Dig, pack, transport, and handle plants with care to ensure protection against injury.

C. Cover plants transported on open vehicles with a protective covering to prevent wind or sunburn.

19.4.5. PROJECT CONDITIONS

A. Work notification: Notify Owner's Representative at least five (5) working days prior to installation of plant material.

B. Protect existing utilities, paving, and other facilities from damage caused by landscaping operations. Call Miss Utility to mark underground utilities a minimum of 48 hours before digging.

C. A complete list of plants, including a schedule of sizes, quantities, and other requirements is shown on the drawings. In the event that quantity discrepancies or material omissions occur in the plant materials list, the planting plans shall govern. Payment shall be based on actual installed plant count.

19.4.6. WARRANTY

A. Warrant plant material to remain alive and be in a healthy, vigorous condition for a period of one (1) year after acceptance, provided plants are given proper care during this period.

1. Contractor to call for final inspection of plants.

B. Remove and immediately replace all plants, as determined by the Owner's Representative, to be unsatisfactory during the initial planting installation.

C. Replace once, in accordance with the drawings and specifications, all plants that are dead or, as determined by Owner's Representative, are in a severely unhealthy condition within warranty period. Replacements to be installed at next best planting season.

D. Warranty shall not include damage or loss of trees, plants, or ground covers caused by fires, floods, drought, freezing rains, lightning storms, or winds over 75 miles per hour, winter kill caused by extreme cold and severe winter conditions not typical of planting areas; acts of vandalism or negligence on the part of the Owner. Any replacement attributed to these causes must be in addition to the contract amount.

19.5. PRODUCTS

19.5.1. MATERIALS

A. Plants: Provide plants typical of their species or variety; with normally developed branches and vigorous root systems. Provide only sound, healthy, vigorous plants free from defects, disfiguring knots, sunscald injuries, frost cracks, abrasions of the bark, plant diseases, insect eggs, borers, and all forms of infestation.

1. Dig balled and burlapped plants with firm, natural balls of earth of sufficient diameter and depth as necessary for full recovery of the plant. Provide ball sizes complying with the latest edition of the "American Standard for Nursery Stock" or local recognized authority. Cracked or mushroomed balls are not acceptable.

2. Container-grown stock shall have grown in a container for sufficient length of time for the root system to have developed to hold its soil together, firm and whole.

- a. No plants shall be loose in the container.
- b. Container stock shall not be pot bound.
- 3. If the use of larger than specified plants is acceptable, increase the spread of roots or root ball in proportion to the size of the plant.
- 4. The height of the trees, measured from the crown of the roots to the top of the top branch, shall not be less than the minimum size and variety designated in the plant list and according to the AAN Standards for Nursery Stock.
- 5. Shrubs and small plants shall meet the requirements for spread and/or height indicated in the plant list and be in accordance with AAN standards.

19.5.2. ACCESSORIES

A. Topsoil for planting beds: Fertile, friable, natural topsoil without admixture of subsoil material, obtained from a well-drained arable site, reasonably free from clay, lumps, coarse sands, stones, plants, roots, sticks, and other foreign materials, with acidity range of between pH 5.5 to 6.0 and be typical of the area.

- 1. Identify source location of topsoil proposed for use on the project.
- 2. Provide topsoil free of substances harmful to the plants which will be grown in the soil.

B. Peat moss: Brown to black in color, weed and seed free granulated raw peat or baled peat, containing not more than 9% mineral on a dry basis.

C. Organic Matter- Organic matter can be from peat moss, compost, or locally available organic waste. Organic matter should be free from debris, weed seeds, and insects or diseases which may be harmful to the intended planting.

D. Fertilizer:

- 1. Plant fertilizer: Commercial type approved by the Owner's Representative, containing 10% nitrogen, 10% phosphoric acid and 10% potash by weight.

E. Anti-Desiccant: Protective film emulsion providing a protective film over plant surfaces;; permeable to permit transpiration. Mixed and applied in accordance with manufacturer's instructions.

F. Water: Hoses or other methods of transportation furnished by Contractor. Water to be provided by the Owner at the site.

- G. Stakes for staking: Hardwood, 2" x 2" (6-8') long (2x4 pine is permissible).
- H. Stakes for guying: Hardwood, 2" x 2" x 24" long.
- I. Guying/staking wire: 12- or 14-gauge galvanized wire.
- 1. Turnbuckles: Galvanized steel of size and gauge required to provide tensile strength equal to that of the wire. Turnbuckle openings shall be at least 3".
- J. Staking and guying hose: Two-ply, reinforced garden hose not less than ½" inside diameter. Shall be uniform in color.
- K. Plastic guy material no less than ¼". Shall be uniform in color and level as applied.
- L. Twine: Two-ply jute material.
- M. Weed control barrier: Rot resistant polypropylene fabric or equivalent, water and air permeable.

19.5. EXECUTION

19.5.1. INSPECTION

- A. Examine proposed planting areas and conditions before installation. Do not start planting work until unsatisfactory conditions are corrected.

19.6. PREPARATION

- A. Time of planting:

- 1. Evergreen material: Plant evergreen materials between September 1 and December 1 or in spring before new growth begins. If Owner requires planting at other times, plants shall be sprayed with anti-desiccant prior to digging operations, weather dependent.
- 2. Deciduous material: Plant deciduous materials in a dormant condition. If deciduous trees are planted in- leaf, they shall be sprayed with an anti-desiccant prior to digging operation.

- B. Planting shall be performed only by experienced workmen familiar with planting procedures under the supervision of a qualified supervisor.

C. Locate plants as indicated on drawings. If obstructions are encountered that are not shown on the drawings, do not proceed with planting operations until Owner's Representative has selected alternate plant locations.

D. Excavate circular plant pits with vertical sides, except for plants specifically indicated to be planted in beds. Provide shrub pits at least twice as wide as the root system and 24" greater for trees. Depth of pit shall be no greater than the root ball depth. Scarify bottom of the pit. Remove excess excavated materials from the site.

E. Provide pre-mixed ground cover bed planting mixture for use around the balls and roots of the plants consisting of five (5) parts existing soil to one (1) part peat moss and 1 lb. plant fertilizer for each cubic yard of mixture or equivalent. Bagged bark professional mixes or an equivalent substitute for peat moss.

F. Provide pre-mixed ground cover bed planting mixture consisting of three (3) parts existing soil to one (1) part peat moss and 1lb. plant fertilizer per cubic yard. Provide beds a minimum of 6" deep. Bagged bark professional mixes or an equivalent substitute for peat moss.

19.6.1. INSTALLATION

A. Set plant material in the planting pit to proper grade and alignment. If Fabric In-ground container material is used, remove fabric bag first. Set plants upright, plum and faced to give the best appearance or relationship to each other or adjacent structure. Set plant material no lower than the finish grade or 2" - 3" above finished grade. No filling will be permitted around trunks or stems. Back fill the pit with existing soil or approved top soil or mix. Form a ring of soil around the edge of each planting pit to retain water.

B. After plants are set, muddle planting soil mixture around bases of balls and fill all voids.

1. Remove all burlap, ropes, and wires from the collar of balls.

C. Space ground cover plants in accordance with indicated dimensions.

D. Watering: Water planting thoroughly to pull soils against root ball and settle air pockets. Additional soil may be needed, water again to ensure complete compaction.

E. Mulching:

1. Mulch tree and shrub planting pits and shrub beds with required mulching material 2" - 3" deep immediately after planting. After watering, rake mulch to provide a uniform finished surface.

2. Mulch ground cover beds with mulch 2" deep before planting.

F. Wrapping, guying, staking:

1. Wrapping should be done only on an as need basis.
2. Staking/Guying
 - a. Stake/guy should only be used when trees are loose or weak stemmed.

(See Staking details on the drawings)

G. Pruning:

1. Remove or cut back broken, damaged and asymmetrical growth of new wood.
2. Unless otherwise directed, prune evergreens only to remove broken or damaged branches.

H. Existing plant relocation:

1. Transplant trees and shrubs designated for relocation to locations shown on the drawings. Prune, dig, ball and burlap, move and plant in accordance with specified tree planting requirements.
2. Prune, dig, ball and burlap, and move designated trees for relocation to the designated plant storage area for heeling-in of materials until final planting areas are prepared, if required.
 - a. Maintain plants in storage areas by bracing plants in vertical position and setting balls in an enclosed berm of topsoil or bark. Water as required to maintain adequate root moisture.
 - b. Re-burlap plant balls if required before final transplanting operations.
 - c. Move to final locations shown on the drawings and plant in accordance with specified tree planting requirements.
3. Transplants are not under warranty.

19.6.2. SUBMITTALS

- A. Submit the following material samples, if requested:

1. Mulch -Bulk or Bagged.

2. Decorative Stone or Gravel -Bag or Bulk

B. Submit the following materials certification, if requested:

1. Topsoil source and pH value.

2. Peat moss, compost, or other organic soil amendments

3. Plant fertilizer.

19.6.3. DELIVERY, STORAGE, AND HANDLING

A. Deliver fertilizer materials in original, unopened and undamaged containers showing weight, analysis, and name of manufacturer. Store in manner to prevent wetting and deterioration.

B. Take all precautions customary in good nursery practice to prepare plants for transport. Workmanship, which fails to meet the highest standards, will be rejected. Spray deciduous plants in foliage with an approved Anti- Desiccant immediately before digging to prevent dehydration. Dig, pack, transport, and handle plants with care to ensure protection against injury.

C. Cover plants transported on open vehicles with a protective covering to prevent wind and sunburn.

19.6.4. PROJECT CONDITIONS

A. Work notification: Notify Owner's Representative at least five (5) working days prior to installation of plant material.

B. Protect existing utilities, paving, and other facilities from damage caused by landscaping operations. Call Miss Utility to mark underground utilities a minimum of 48 hours before digging.

C. A complete list of plants, including a schedule of sizes, quantities, and other requirements is shown on the drawings. In the event that quantity discrepancies or material omissions occur in the plant materials list, the planting plans shall govern. Payment shall be based on actual installed plant count.

19.6.5. MAINTENANCE

- A. Maintenance of installed and accepted plantings will be performed by the Owner.
- B. Contractor's maintenance shall include pruning, cultivating, weeding, watering, and application of appropriate insecticides and fungicides necessary to maintain plants free of insects and disease until acceptance.
 - 1. Re-set settled plants to proper grade and position. Restore planting saucer and adjacent material and remove dead material.
 - 2. Tighten and repair guy wires and stakes as required, only if originally needed.
 - 3. Correct defective work as soon as possible after deficiencies become apparent and weather and season permit.
 - 4. Water trees, plants and ground cover beds.

19.6.6. ACCEPTANCE

- A. Planted areas will be inspected at completion of installation and accepted subject to compliance with specified materials and installation requirements.
- B. Inspection upon contractors request to determine acceptance of planted areas will be made by the Owner's Representative.
 - 1. Planted areas will be accepted provided all requirements have been complied with and plant materials are alive and in a healthy, vigorous condition.
- C. Sections of the work may be accepted when complete upon agreement of the Owner's Representative and the Contractor.
- D. Upon acceptance, the Owner will assume plant maintenance.

19.6.7. CLEANING

- A. Perform cleaning during installation and upon completion of the work. Remove from site all excess materials, soil, debris, and equipment. Repair damage resulting from planting operations.

19.7. SODDING

19.7.1. DESCRIPTION

A. Provide sodded lawns as shown and specified. The work includes:

1. Soil preparation.
2. Sodding lawns.

B. Related work:

1. Earthwork.
2. Seeding.
3. Trees, Plants, and Ground Covers.

19.7.2. QUALITY ASSURANCE

A. Comply with LANDSCAPE GENERAL requirements (3.1 – 3.4).

B. Sod: Comply with American Sod Producers Association (ASPA) classes of sod materials or recognized local authority.

19.7.3. SUBMITTALS

A. Submit sod grower's certification of grass species. Identify source location.

19.7.4. DELIVERY, STORAGE, AND HANDLING

A. Cut, deliver and install sod within a 48-hour period.

1. Do not harvest or transport sod when moisture content may adversely affect sod survival.
2. Protect sod from dehydration prior to installation.

19.7.5. PROJECT CONDITIONS

A. Work notification: Notify Owner's Representative at least five (5) working days prior to start of sodding operations.

B. Protect existing utilities, paving, and other facilities from damage caused by sodding operations.

C. Provide hose and lawn watering equipment as required. Owner to provide water on site.

19.7.6. WARRANTY

A. Disclaimer - Acts of God and other conditions beyond the landscape contractor's control such as vandalism shall not be the responsibility of the landscape contractor. Any re-sodding or re-grading contributed to this must be an addition to the contract amount.

19.8. PRODUCTS

19.8.1. MATERIALS

A. Sod: As recommended by VPI and SU for the area or local Extension Service.

B. Provide well-rooted, healthy sod. Provide sod uniform in color, leaf texture, density and development when planted.

1. Furnish sod uniformly machine-stripped from $\frac{3}{4}$ " - 1 $\frac{1}{2}$ " thick with clean cut edges.

C. Fertilizer:

1. Granular, non-burning product composed of not less than 50% organic slow acting, guaranteed analysis professional fertilizer.

2. Starter fertilizer containing 5% nitrogen, 10% phosphoric acid and 10% potash by weight, or according to special provisions.

D. Ground limestone: Containing not less than 85% of total carbonates and ground to such fineness that 50% will pass through a 100 mesh sieve and 90% will pass through a 20 mesh sieve.

E. Water: Free of substance harmful to sod growth. Hoses or other methods of transportation furnished by Contractor. Water will be provided by the Owner on site.

19.9. EXECUTION**19.9.1. INSPECTION**

A. Examine finish surfaces, grades, topsoil quality, and depth. Do not start sodding work until unsatisfactory conditions are corrected.

19.9.2. PREPARATION

A. Limit preparation to areas which will be immediately sodded.

B. Loosen topsoil of lawn areas to minimum depth of 3", if compacted. Remove stones over 1" in any dimension, sticks, roots, rubbish, and extraneous matter.

C. Apply limestone as required to adjust pH of topsoil to not less than 5.5 nor more than 6.8. Distribute evenly by machine and incorporate thoroughly into topsoil.

D. Apply fertilizer at the rate equal to 1.0 lb. of actual nitrogen per 1,000 sq. ft. (220 lbs./acre). Apply fertilizer by mechanical rotary or drop type distributor: thoroughly and evenly incorporate it into the soil to a depth of 3" by disking or other approved methods. Fertilize areas inaccessible to power equipment with hand tools and incorporate it into soil.

E. Grade lawn areas to smooth, free-draining and even surface with a loose, uniformly fine texture.

F. Restore prepared areas to specify condition if eroded, settled, or other-wise disturbed after fine grading and prior to sodding.

19.9.3. INSTALLATION

A. Sodding:

1. Lay sod to form a solid mass with tightly-fitted joints. Butt ends and sides of sod strips. Do not overlay edges. Stagger strips to offset joints in adjacent courses. Remove excess sod to avoid smothering of adjacent grass. Provide sod pad top flush with adjacent curbs, sidewalks, drains, and seeded areas.

2. Install initial row of sod in a straight line, beginning at bottom of slopes, perpendicular to direction of the sloped area. Place subsequent rows parallel to and lightly against previously installed row.

3. Tamp or roll with roller to ensure contact with sub-grade soil.

4. Water sod thoroughly one time immediately after laying.
5. Stake sod on slopes over 2:1 to anchor.
- B. Sod indicated areas within contract limits. Areas outside contract limits disturbed as a result of construction operations are to be charged according to size of area.

19.9.4. MAINTENANCE

- A. Maintenance of installed and accepted sodded lawns will be performed by the Owner.

19.9.5. ACCEPTANCE

- A. Sodded areas will be inspected at completion of installation and accepted subject to compliance with specified materials and installation requirements.
- B. Inspection to determine acceptance of sodded lawns will be made by the Owner's Representative, upon Contractor's request.
 1. Sodded areas will be acceptable provided all requirements have been complied with, and a healthy, even-colored viable lawn is provided.
- C. Sections of the work may be accepted when complete upon agreement of the Owner's Representative and the Contractor.
- D. Upon acceptance, the Owner will assume lawn maintenance.

19.9.6. CLEANING

- A. Perform cleaning during installation of the work and upon completion of the work. Remove from site all excess materials, debris, and equipment. Repair damage resulting from sodding operations.

END OF SECTION

TENDER DOCUMENTS (VOLUME-III)
TECHNICAL SPECIFICATIONS (PUBLIC HEALTH WORKS)

TECHNICAL SPECIFICATIONS PUBLIC HEALTH WORKS

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TECHNICAL SPECIFICATIONS

1. PLUMBING, FITTINGS AND FIXTURES

1.1. SCOPE

The work under this section consists of providing all material and equipment and performing all the work necessary for the complete execution (jointing, clamping, cleaning, painting etc. both above and underground and embedded in walls) and completion, including testing and commissioning of all systems of plumbing works as shown on the Drawings and/or as specified herein and/or as directed by the Engineer. The system includes plumbing works as follows:

- a. Cold and Hot Water Supply
- b. Building Drainage
- c. Rain Water Drainage
- d. Storm water Drainage

All the above named systems shall be completed in all respects including extension of these internal systems up to the specified limits outside the building as indicated on the drawings. All hookup systems are also included in scope of work like water supply connections to existing line, connection of sewer to existing manhole etc.

1.2. APPLICABLE STANDARDS

G. I. Pipes	BS- 1387
Polypropylene Random (PPR) pipes	DIN 8077-8078
UPVC Pipes	ISO- 3633 (Type B), EN1329 & BS- 4514/ 5255 (Class B)
MS Pipe	ASTM106GB

1.3. SUBMITTALS & SHOP DRAWINGS

- 1.3.1. All the materials and equipment 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 approval of Engineer Incharge. All material and equipment shall be new, approved and unused.
- 1.3.2. It is specifically intended and must be agreed to by each CONTRACTOR submitting a bid, that any material or labor 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.
133. Approval of material and equipment by the Engineer shall not absolve the SUB-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.
134. Prior to commencement of works on site and at least 3 weeks in advance of all the drawing being required for actual execution the CONTRACTOR shall submit on larger scale as approved by Engineer, shop drawings in triplicate for approval to the Engineer. The Engineer shall review the drawing and (1) approve the drawing or, (ii) approve the drawing with comments or, (Hi), disapproved the drawings with comments for rectification/revision of the drawing and resubmit 3 copies to the Consultant for approval. On a drawing being approved, the SUB-Contractor shall submit 6 copies for formal approval and distribution to relevant offices.
135. All drawings shall have plan and section and with sufficient details to clearly reflect the installation of the system. All material specifications shall be provided on the drawings. All information required for preparing suitable foundation, for providing suitable access to the system, for making openings in building structure, for coordination with electrical, air-conditioning and other-discipline etc., shall be clearly provided.
136. Installation shall not be allowed to commence unless approved shop drawings are in possession of the CONTRACTOR, for which purpose shop drawings shall be submitted by the CONTRACTOR to the Engineer sufficiently in advance of actual requirements to allow for ample time in checking and approval and no claim for extension of the contract time will be considered by reason of the SUB-Contractor's failure to submit the shop drawings on time.
137. Each shop drawing submitted by the CONTRACTOR shall include a certificate by the CONTRACTOR that all related conditions. on site relevant to that particular installation have been checked and that no conflict exists.
138. Any expenses resulting from an error mistake or omission in or delay in delivery of the drawings and information mentioned above shall be borne by the SUB-Contractor.
139. Drawings approved shall not be departed from except on the instructions of the Engineer.
- 13.10. The approval by the Engineer for any submitted data, working drawings, performance curves, test certificates for any items, arrangements and/or layout shall not relieve the CONTRACTOR from any responsibility regarding the performance of the Contract. Such approval shall not also relieve the SUB-

Contractor from responsibility of any error in the submitted data and workings, brought to light at any time subsequent to any approvals.

- 13.11. Relevant specified imported item, model cuts will be available with the authority concern for execution of work for CONTRACTOR to check the models for fabrication or import.

14. MATERIAL & EQUIPMENT

14.1. G.I. COLD, HOT WATER PIPES AND FITTINGS

The galvanized pipes shall be of medium grade 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 tube shall be tested at the manufacturer's works to a hydraulic test pressure of 4.90 MPa and shall 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 good quality grease or other suitable compound, and each tube above 50 mm nominal bore shall have a protecting ring affixed to the un socketed screwed end.

All pipe fittings upto 75 mm dia. shall conform to BS 21 and shall be of malleable cast iron. Pipe fittings above 75 mm dia. shall be of approved material and specifications as decided by the Engineer.

14.2. POLYPROPYLENE RANDOM (PPR) PIPES AND FITTINGS

Polypropylene Random Pipes and fittings shall conform to the following standards:-

- DIN 8078 Resistible to all chemical elements
- DIN 16961 Smooth inner surface
- DIN 19560 Usability for hot water all levels
- DIN 4279 Durable to inner pressure
- DIN 16962 Conforms to connections by welding process

143. VALVES

Generally, all valves of the same type shall be of the same manufacturer. All gate, globe, angle, and swing check valves as a group shall be of the same manufacturer. All valves 50 mm and smaller shall be threaded and have bronze bodies.

All valves 65 mm and larger shall be Cast iron type and shall be flanged (or grooved for grooved coupling joints).

For PPR piping use PPR Coated valves of the same piping material and manufacturer.

Each valve shall be marked (engraved, stamped, or cast on each valve or metal tag, permanently attached to the valve) at the factory with the following minimum information

- a. Manufacturer's Name.
- b. Catalogue or Figure No. Size and Pressure Class.

Arrows to indicate direction of flow on check, globe, angle, non-return, and eccentric plug valves.

144. GATE VALVES

[Size 50 mm and Smaller]. Furnish bronze valves with screwed-in bonnet, non-rising stem, solid wedge disc, and threaded ends. Pressure rating N20.

[Size 65 mm and Larger]. Furnish Iron Body Bronze Mounted (IBBM) valves, i.e. cast iron body bronze trim valves, with bolted bonnet, non-rising stem, solid wedge disc, flanged ends, and renewable seat rings.

145. GLOBE VALVES

[Size 50mm and Smaller]. Furnish valves designed for minimum PN20 working pressures.

[Size 65 mm and Larger]. Furnish valves designed for minimum PN16 working pressure.

146. CHECK VALVES

[50 mm and smaller]. Furnish swing valves designed for minimum PN20 non-shock working pressures. Valves shall have renewable discs and side plugs, integral seats.

[Size 65 mm and Larger Water Check Valves]. Valves shall be silent type spring loaded of the double door or wafer style. Valves shall be designed for minimum PN16 non shock water working pressure.

147. RELIEF VALVES

Domestic Water Temperature and Pressure Relief Valve.

On hot water storage tanks provide an ASME rated thermostatic, self-closing, temperature and pressure relief valve, located in the relief valve openings of tanks.

Valve shall have a minimum thermal discharge capacity equal to the input capacity of the heater standard pressure setting of 600 kPa and standard temperature setting of 100 - 140 degrees C. Relief valve pipe to discharge to floor drain.

14.8. BALL VALVES

[Size 50 mm and Smaller]. Valves shall be standard port, 2-piece construction with screwed ends. Valves shall be designed for minimum PN25. Valves shall have bronze or brass body, stainless steel ball, steel handle with vinyl grip.

[Size 65 mm and Larger]. Valves shall be standard port, BS 5159 with flanged ends. Valves shall be designed for minimum PN16 working pressure. Valves shall have steel body, chrome or nickel plated steel or stainless steel ball.

14.9. FLOAT VALVES

Float valves shall be installed as indicated in the drawings to provide consistent level control in reserve supply water storage tanks. The valve shall meet the requirements of the Water Byelaws for air gaps and shall be constructed throughout in approved materials and shall prevent back siphoning. Bronze equilibrium float valves 80 and above shall be flanged end, flat faced and drilled to suit BS4504 PN16.

Bronze equilibrium float valves upto 50 shall be screwed end BS2779 parallel and shall be provided complete with back nut.

Floats for valve sizes 80mm and above shall be of copper.

14.10. SOIL, WASTE, VENT & RAIN WATER DRAINAGE PIPES & PIPE FITTINGS (C. I. & uPVC)

14.11. UPVC Pipes

The material shall substantially consist of Poly Vinyl Chloride (PVC) as per the requirements of aforesaid standard. Pipes and fittings shall be sufficiently stabilized against thermal ageing and ultraviolet (UV) light.

14.12. PIPES

There are two types of pipes and fittings (type A and type B) as per ISO 3633 for drainage systems.

Type A, which shall be used only for primary and secondary ventilation pipe work and internal rainwater applications.

Type B, which shall be used for soil and waste discharge systems and may also be used for any type A application.

Unplasticised polyvinyl chloride (PVC-U) pipes and fittings for soil and waste discharge (low and 'high temperature) systems inside the buildings shall conform to ISO: 3633: (1991(E)) type B.

14.13. FITTINGS

There are two types of fittings available as per ISO 3633:

UPVC fittings with Solvent Cement (SC) socket joint conforming to ISO 3633:1991.

UPVC fittings with rubber ring socket joint conforming to DIN 19560, which is compatible with ISO 3633/PS 3214.

14.14. RUBBER RINGS

The rubber rings may either be Synthetic or natural conforming to PS 1915:1987 & ISO 4633/1983 (E).UPVC pipes shall be used for domestic installation inside the buildings for soil and waste discharge, ventilation and drainage of rain water.

The material shall consist substantially of poly-vinyl chloride (PVC) to which may be added only those additives that are needed to facilitate the manufacture of pipes and fittings having good mechanical strength and opacity.

The pipes and fittings shall be tested mechanically and physically in accordance with the relevant Standards as and when directed by the Engineer, before and during installation.

15. PLUMBING FIXTURES

15.1. 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 the best quality and finish.

15.2. 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 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 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 to be purchased.

15.3. 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 material or equipment offered under this provision is, in the opinion of the Engineer, equal to or better than specified, it will be given consideration.

15.4. 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.

155. All taps and cocks to be installed with plumbing fixtures shall be chrome plated (CP) and shall be of appropriate class to work without damage or leakage on the specified pressure of potable water system, which is 0.88 MPa (128 psi). The taps and cocks shall be of the best quality locally manufactured.
156. When any fixture is provided with an overflow, the waste shall be so arranged that the standing water in the fixture cannot rise in the over flow when the stopper is closed or remain in the overflow when the fixture is empty.
157. 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.
158. 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 is transmitted to the connections. Flush tanks and similar appurtenances shall be secured by approved non-corrosive screws or bolts.
159. Fixtures shall be set level and in proper alignment with reference to adjacent walls. No water closet shall be set closer than 400 mm from its centre to any side wall. No urinal shall be set closer than 300 mm from its centre to any side wall or partition nor closer than 600 mm 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.

Other physical/chemical properties of the fixtures are as below:

S. No.	Physical / Chemical Properties	Pakistan Standards	European Standards
1.	Water absorption	Less than 0.50%	Maximum 0.5%
2.	Scratch Resistance	Maximum 5.5 MOH's scale	Maximum 5 MOH's scale
3.	Resistance to Chemicals	Resistant to acids, alkalies, bases & other household cleaning chemicals	Resistant to chemicals.
4.	Crazing Resistance	Crazing *NIL*	Crazing *NIL*
5.	Warpage	Maximum 5.5-6mm	Maximum 6mm
6.	Strength against	More than 700 kg/cm	450kg/cm – 700

	bending		kg/cm
7.	Thermal shock	More than 10 cycles of thermal shock from hot to cold water 15 ^o C-200 ^o C	More than 2 cycles of thermal shock from hot to cold water 20 ^o C-110 ^o C
8.	Durability	Permanently durable	Durable for ever

15.10. COUNTER TOP LAVATORIES/WALL HUNG LAVATORY

White vitreous china 302, SS self-rimming, min. dimension of 19" wide x 17" front to rear with supply openings for use with top mounted centre set faucets, furnished template and mounting kit by lavatory manufacturer. Mount counter with the top surface 34" above floor and with 29" min. clearance from bottom of the counter face to floor. Provide top mounted washer-less centre-set lavatory faucet.

15.11. FLUSH TANK WATER CLOSET/WALL HUNG WATER CLOSET

White Vitreous China, 302 SS, Siphon Jet, Round Bowl, Pressure Assisted, Floor-mounted, Floor Outlet. Top of Toilet Seat Height above floor shall be 14 to 15 inches, except for 17 to 19 inches for wheel chair WC's. Provide wax bowl ring including plastic sleeve. Water flushing of the WC shall not exceed 6 litres per Flush. Provide a dual flush toilet with a second flushing option that shall not exceed 4 litres per flush. Provide white solid plastic round closed front seat with cover.

15.12. WATER CLOSETS (ORISSA)

Floor mounted Indian type commode with all allied accessories, color to match floor tiles, complete installation as shown on drawings and as directed by the Engineer.

15.13. URINALS

White vitreous china SS wall mounted wall outlet, Siphon Jet integral trap and extended side sheets. Provide Urinal with the rim 17" above the water flushing volume of the urinal.

16. MISCELLANEOUS ITEMS**16.1. KITCHEN SINK**

Provide 42" single-deep bowl, single tray finish to be brushed stainless steel.

16.2. BATHROOM FAUCET

Provide bathroom faucet with push-button function. Finish to be chrome plated.

- 16.3. HANDICAP BATHROOM FAUCET
Provide handicap compliant goose neck faucet with two lever handles finish to be chrome-plated.
- 16.4. KITCHEN FAUCET
Provide wall mounted goose neck faucet with two lever handle finish to be chrome plated.
- 16.5. MUSLIM SHOWER
Provide Muslim Shower with adjustable pressure for jet-spray. Provide all accessories including wall hanging brackets, Fixing, steel hose finish being mirror chrome.
- 16.6. LOOKING MIRROR
Provide imported mirror with bevelled/polished edges, mirror to be fixed with SS clamps of the sizes mentioned in the Schedule of values.
- 16.7. TOILET PAPER HOLDER
Furnish Type-II surface mounted toilet tissue holder with two rolls of standard tissues, mounted horizontally. Provide SS satin finish.
- 16.8. SOAP DISPENSER
Provide soap dispenser surface mounted liquid type consisting of a tank with holding capacity of 1.2 litres with a corrosion resistant al purpose wall that dispenses liquid soap lotions, detergents and antiseptic soaps.
- 16.9. ROBE HOOK
Provide Robe Hooks with concealed fastenings with maximum projection of 4", Provide one hook for every toilet compartment door, mounting at 5' above the finish floor, Robe Hooks are SS with satin finish.
- 16.10. GRAB BAR
Provide an 18 Gauge 1.25" grab bar of type 304 SS, Provide form and length for grab bars as indicate on drawings. Provide concealed mounting flange, provide grab bar with satin finish, furnish installed bars capable of withstanding 2.225 KN vertical load without coming loose from the fastening and without obvious permanent deformation, allow 1.5" space between wall and grab bars.
- 16.11. ELECTRIC WATER HEATER
Electric Water Heater thermally efficient and having stainless steel tank of capacity 15 litres and 50 litres as shown on drawings shall be supplied and installed. Electric water heater shall be storage type. All heaters, after installation, shall be subjected to an operation test to determine the efficient working of the recovery side, thermostat, etc. to the satisfaction of the

Engineer. The Engineer prior to supply and installation shall approve all heaters. The authorities having jurisdiction and any other governing regulations shall approve all heaters.

1.6.12. INSTANT GAS WATER HEATER

The instant gas water geyser must be thermally efficient and user friendly. The capacity of Instant Gas Water Heater should be 12 litres per minute. Being the tank-less water geyser, it heats the water instantaneously. The outer casing of the geyser is made of mild steel sheet painted with anti-corrosive powder. The inner body is made of copper. Both the bodies are thermally insulated from each other. These heaters must have a safety system which automatically shuts off the instant water heater if the temperature goes beyond safety limits.

1.6.13. MOP SINK

MOP Sink to be installed where shown on the drawings, Terrazzo shall be of marble chips cast in white Portland cement to produce 25 MPA minimum compressive strength 7 days after casting, provide floor or wall outlet copper alloy body drain cast integral with terrazzo, with polished stainless steel strainers.

1.6.14. FLOOR TRAP/DRAIN

Floor trap/drain shall be of UPVC or of other anti-corrosive material, compatible with the material of pipe. They shall have minimum water seal of 40 mm and shall be provided with removable metal/uPVC strainers. The traps shall be of self-clearing 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.

1.6.15. ROOF DRAINS

Roof drains shall be of bitumen coated cast iron/ brass or UPVC or of other anti-corrosive material, compatible with the material of pipe. They shall have strainers extending at least 15 mm above the roof surface immediately adjacent to them, when installed on flat part. Bottom of strainer shall be flush with the roof surface, when installed on vertical part. 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.

1.6.16. CLEANOUTS

Cleanout shall be of the same nominal size as that of the pipe on which it is installed. Cast iron Cleanout shall consist of tapped heavy duty cast iron ferrule caulked into cast iron fitting and heavy duty brass tapered even plug. UPVC

cleanout shall consist of either two 45° bends or one long radius bend both with an removable end cap and other necessary fittings/material for complete installation in floor. Cleanouts shall be turned up through floors by long sweep fittings, wherever the space so permits. Top finish of cleanout shall be flush with the floor 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 300 mm for pipes less than 75 mm diameter and at least 457 mm for pipes of 75 mm and larger diameter, for the purpose of roding.

Pipe used with cleanout shall be measured and paid under pipe item. All other work of ferrule, plug, concrete work, frame and cover etc. shall be measured and paid under cleanout item.

16.17. GULLY TRAP

Gully trap shall be of cast iron with specified size outlet. The inlet shall be provided with cast iron, medium duty grating. The open area of the grating shall be at least 1-1/2 times the area of the outlet. The trap shall be of P-Type with a minimum water seal of 50 mm.

16.18. CAST IRON GRATING

Cast iron grating shall be of the specified size. The specified size shall mean the clear span. Cast iron grating shall be complete with frame. They shall be of Light/medium duty type to resist normal traffic loads, the casting shall be sound and free from all defects. The frame shall be set in place at the time of pouring of concrete. Openings in grating shall be in approved pattern.

16.19. 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 stain-less steel tray. Back panel shall be easily remove-able 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, -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. The thermostat shall control the temperature of cooled water between + 11°C & + 20°C.

16.20. WATER FILTERS

Water filters shall be installed on wall near the water coolers. They shall be of best quality local/foreign make. Each filter shall have a crystal housing of a

durable material. The flow rate shall be 2 to 6 gpm with a maximum pressure of 70psi and a temperature of 35°F to 100°F.

Stage 1:- Stage 1 shall use a "poly propylene Yarn In depth Sediment filter cartridge", for removal of dust, rust, silt, scale and unseen suspended particles. It shall have a filtration rating of 5-micron.

Stage 2:- In this stage a "Granular Activated Carbon (GAC) cartridge" equipped with a post-filter of 1-micron is recommended, for removal of chemicals and unpleasant taste and odor.

Stage 3:- This stage must provide 30,000 MW.sec/sq.cm energy to guarantee '100% sterilization and ensure effective control of microbiological contamination.

1.7. EXECUTION

GENERAL

- 1.7.1 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 or stolen without any additional cost.
- 1.7.2 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.
- 1.7.3 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.
- 1.7.4 All special tools for proper operation and maintenance of the equipment provided under this Contract shall be delivered at no additional cost. The SUB-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.
- 1.7.5 The CONTRACTOR shall allow in his bid for the cost of providing protective painting or coating as specified in the relevant sections and no claim shall be entertained for this item.
- 1.7.6 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.
- 1.7.7. The arrangement, positions and connections of pipe fittings and appurtenances shall be as shown on the drawings. The Engineer reserves 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 to other works in the correction of piping. The SUB-Contractor shall closely coordinate with other works during the entire stage of execution.
- 1.7.8. A minimum distance between different services shall be maintained as shown on the Drawings and/or as approved by the Engineer.
- 1.7.9. 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.
- 1.7.10. Waste-water outlet from each fixture shall be individually trapped. Each vent terminal shall extend to the outer air and be so installed as to minimize the possibilities of clogging and the return of foul air to the building.
- 1.7.11. 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 water tight. Cast iron soil and drainage fittings for change in direction shall be used as follows:-
- a. *Vertical to horizontal: short sweep or long-turn for diameter 75 mm and larger; long sweep or extra-long-turn for less than 75 mm. dia.
 - b. *Horizontal to vertical: quarter bend or short turn.
- 1.7.12. All fittings with hubs shall be aligned so that the hub faces upstream. No drainage or vent piping shall be drilled.
- 1.7.13. 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.
- 1.7.14. Joints at the roof, around vent pipes, shall be made water-tight by the use of Lead, copper, galvanized iron, or other approved flashing or flashing material. Exterior wall openings shall be made watertight.
- 1.7.15. Each length of pipe & each pipe fitting, trap, fixture, & device used in a plumbing system shall have cast, stamped or indelibly marked on it the maker's mark or name, the weight, type & 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 reducers or reduced fittings shall be used between the two sizes.

- 1.7.16. 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. The vertical distance from the fixture outlet to the trap weir shall not exceed 600 mm: Each fixture trap shall have a water seal of not less than 50 mm and not more than 100 mm.
- 1.7.17. Full S, bell, crown vented traps 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 joint shall be water-tight. Piping in ground shall be laid on a firm bed for its entire length.
- 1.7.18. 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 SUB-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.
- 1.7.19. The run and arrangement of all pipes shall be as shown on the Drawings and as directed during installation. All vertical pipes shall be erected plumb 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.
- 1.7.20. Furnish and install all pipes passing through floors and walls with sleeves of G.I. sheet, 18 gauges, the inside dia. of which shall be at least 1/2" greater than the outside dia 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 approved water-proof type pipe sleeve shall be provided.
- 1.7.21. All embedded water supply piping shall be wrapped with approved anti-corrosion polyethylene tape. All exposed piping shall be painted with two coats of enamel paint over a coat of red oxide:-
- 1.7.22. Insulation

All hot water supply and return piping shall be insulated as specified herein. Prior to insulation the pipes shall be hydraulically tested and cleaned.

Nominal Pipe Dia. (mm)	Thickness of pre-formed Fiber glass pipe insulation. (mm)
15 (1/2")	25
20 (3/4")	25
25 (1")	25
32 (1-1/4")	25
38 (1-1/2")	
50 (2")	

- 1.7.23. Insulation shall consist of pre-formed fiberglass pipe insulation, with factory applied reinforced aluminum vapor barrier, single layer in semi-circular halves, consisting of long, fine glass fibers, bonded with a temperature resistant binder, free from shot or coarse fibers, damage resistant, light in weight, easy to handle, cut and fit. The product shall comply with the requirements of B.S. 3958: Part 4. The insulation shall be rot proof, odorless, non-hygroscopic, and shall not sustain vermin. The fiberglass insulation shall be covered with a layer of approved polyethylene tape in the field. Further reinforcement shall be provided by the use of 20 mm wide soft aluminum bands, generally spaced at 457 mm and on either side of elbows and tees. All butt joints shall be sealed with self-adhesive type of approved quality adhesive tape.

- 1.7.24. All trimmed sections shall be secured by wrapping of approved type of self-adhesive tape to form a complete waterproof seal. All work shall be done in a neat and workmanlike manner, and should reflect recommended practice.

All Hot water and Hot water return lines concealed in walls only, shall be provided with Glass wool blanket insulation.

- 1.7.25. Pipe work Supports

All supports, clips, steel rods and hangers shall be of mild steel painted with two coats of approved metallic zinc prime (All clips and brackets shall be equipped with 9 mm sectional rubber liners (shore-hardness A 40+5°).

Pipe work supports shall be installed in order to allow free movement due to expansions and contraction. Supports shall be arranged adjacent to joints, changes of direction and branches. Each support shall carry the overall weight of pipe work and water to be borne by it. The intervals between pipe supports shall not exceed the following:

Maximum interval between supports (metres)		
Nominal Dia mm	Steel pipes	
	Horizontal.	Vertical
10	1.7	1.7
15	2.0	2.0
20	2.4	2.4
25	2.7	2.7
32	2.7	2.7
40	3.0	3.5
50	3.4	3.9
65	3.7	4.3
80	3.7	4.3

Dimensions of Support Materials

Nominal Dia mm	Flat iron bands mm	Support rods mm	U-bolts mm
10	25 x 3	6	6
15	25 x 3	6	6
20	25 x 3	6	6
25	25 x 3	6	6
32	40 x 5	10	10
40	40 x 5	10	10
50	40 x 5	10	10
65	50 x 6	12	12
80	50 x 6	12	12

- 1.7.26. Single pipes hung from floor slabs shall be supported on rod hangers. Where two or more pipes are involved a channel or angle iron shall be fitted to the underside of slab by two hangers and the pipes shall be supported from the channel iron by rod hangers and flat iron bands.
- 1.7.27. 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.
- 1.7.28. 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 pipe work running along skirting shall be supported by standard built-in or screw-on type clips.

- 1.7.29. 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 points to withstand the total weight of the riser. Brackets from risers shall not be used as a means-of support for the riser. Vibration isolators to be provided with the hangers as approved by the Engineer.

1.8. POLYPROPYLENE RANDOM PIPES & Jointing

1.8.1. Jointing Techniques

The surfaces of the pipes and fittings must be clean and without impurities. Pipe ends must be clean, cut at right angles. It is recommended to cut 1cm from the pipe ends in order to prevent possible micro-cracking due to incautious handling.

- 1.8.2. Before carrying out the welding, check that the poly-fusion device operates correctly and that it reaches the required welding temperature ($260^{\circ}\text{C} \pm 5$).Jointing is done by heat fusion (welding) by means of welding machine. Welding is carried out by means of heating simultaneously the male and female parts to be joined together, once the welding temperature is reached the joint is made and held for cooling time. (see table I below)
- Welding Instructions using socket welding machine
 - Check whether the welding tool corresponds to the size you need to join.
 - The welding tool/device has reached the necessary operating temperature of $260^{\circ}\text{C} \pm 10$
 - Cut the pipe at right angles to the pipe axis by using cutter or a hack saw.
 - Clean the pipe from burrs, cutting and chips
 - Mark the welding depths at the end or pipe
 - Push the end of pipe up to the marked welding, depths in the welding tool, at the same time push the fitting, into the welding tool.

183. After the stipulated heating time quickly remove pipe and fitting from the welding tools and join them immediately, forcing the pipe into the fitting until the marked welding depth is covered by the bead of Polypropylene from the fitting. The joint elements have to be fixed and aligned within the specified assembly time.
184. After the cooling time the fused joint is ready for use. The heating time starts when pipe and fitting have been pushed to the correct welding depth in the welding tool

Est. Diameter (mm)	Welding. Depth (mm)	Heating Time DVS 2207(sc.)	*	Heating Time (sc.)	Cooling Time (min.)
20	14.0	5	8	4	2
25	15.0	7	11	4-	2
32	16.5	8	12	6	4
40	18.0	12	18	6	4
50	20.0	18	27	6	4
63	24.0	24	36	8	6

The heating time have to be increased 50% if average temperature is under + 5°C

Welding of PPR Pipes

Cutting of pipe at right angle with a cutter

Marking of welding depth on the pipe end

Simultaneous heating of both pipe and fittings according to required heating time (as per given data).

Pushing of pipe end into the fitting and alignment of the assembly within specified time period

185. Finish joint / Installation Principles

Fastening technique for open installation

The selection of fastening material and its application have to be determined as:-

Fixed Point

Sliding Point

Pipe clamps are such as to meet all requirements and- ensure that no mechanical damage on the pipe surface can occur.

186. Fixed Point

Valves and connections resisting to bending stresses have to be fastened by means of points. In particular cases the fixed points are to be positioned closed

to branches or wall passages. The axial expansion will be compensated between two points. To assess the resistance of the fixed points one has to take into account the stresses to which they will be subjected, caused by linear expansion, weight of the piping and weight of the transportation fluid. Fixed points should be delimited on both sides of the clamp, availing oneself of the rim fittings or valves.

1.8.7. Sliding Point

The sliding points must keep the system aligned and support it, and allow the axial sliding of the piping as well. The sliding are to be firmly mounted in order to prevent vibration and transmission of noise.

Distance between the support points in cm.

Pipe diameter	Temperature in °C		
	20	50	80
20mm	85	70	60
25mm	85	80	70
32mm	100	85	85
40mm	110	100	90
50mm	125	110	90
65mm	140	125	105

19. SOIL, WASTE, VENT & RAIN WATER DRAINAGE PIPES & PIPE FITTINGS (C.I. & uPVC)

- 19.1. All uPVC 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 systems. Clamps shall be provided on not more than 1.5 meter 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.
- 19.2. All steel clamps, hangers and support etc. shall be given one coat of red oxide primer and 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. Pipes passing through walls, floors, etc. shall be provided with sleeves of approved design. AU vent pipes to be installed in the system shall be provided with approved cowl and will rise at least 0.70 meter above the roof.
- 19.3. Special requirements for uPVC Pipes and fittings are as under:

Maximum Interval between Supports (m)

(Support centers for uPVC pipe work systems)*

Nominal Diameter, d_e	PIPEWORKS Horizontal ($10 \times d_e$)	Vertical
(mm)	(m)	(m)
40	0.40	1.2
50	0.50	1.5
75	0.75	2.0
110	1.10	2.0

* The values shown are for general installations only. Attention is drawn to special requirements that may be needed in more demanding applications. All steel clamps, hangers, supports etc. shall be given one coat of red oxide primer and two coats of synthetic enamel paint.

19.4. PRECAUTIONS

Following points describe how an uPVC must be cared of:

The depth of concrete cover above uPVC pipe depends on the pipe gradient. However, a minimum of 1 (one) inch concrete cover must be provided.

When using cemented joints, the adhesive should be given sufficient opportunity to harden before the pipe is concreted in.

Horizontal lines that are concreted-in should be anchored against upward movement and should be adequately secured while the concrete is being poured.

During the pouring and setting of concrete, necessary care shall be taken to prevent physical damage to the pipes.

When using heated concrete or when steaming the concrete, the sensitivity of uPVC material to temperature changes should be borne in mind.

Concrete mortar that is used before concreting shall include no sharp-edged material.

1. Avoid excessive misalignment of the pipes.
2. Avoid excessive tightness of joints.

Provide sufficient expansion joints to allow thermal movement or regression.

Use only allowed cleaning & descaling techniques for different situations & locations (as described in ISOTTR 7024-1985E) when a pipeline gets choked or blocked.

1.95. DELIVERY CONDITIONS

The internal and external surfaces of pipes and fittings shall be smooth and free from grooving, blistering and any other surface defect. The materials shall not contain visible impurities or pores. Pipe ends shall be cleanly cut, and the ends of pipes and fittings shall be square with the axis of the pipe

1.96. MARKINGS

Pipes, fittings and sealing rings shall be marked clearly and indelibly so that legibility is maintained for the life of products under normal conditions of storage, weather and use.

The markings may be integral with the product or on a label. The markings shall not damage the product.

1.97. PIPES

Pipes shall be marked with at least the following information:

Manufacturer's name or trade mark;

Pipe material;

Nominal diameter of pipe;

Nominal wall thickness of pipe

Manufacturing information, in plain text or in code, providing tractability of the production period to within the year and month and the production site if the manufacturer is producing at several national or international sites.

The number of this International Standard.

Fittings

Fittings shall be marked with at least the following information:

Manufacturer's name or trade mark;

Fitting material (may be given on packing only in the case of PVC, provided this information is not required on each article by national authorities);

Nominal diameter of fitting;

Classification (where applicable).

Values of angles, if any;

Manufacturing information, in plain text or in code, providing tractability of the production period to within the year and month and the production site if the manufacturer is producing at several national or international sites (May be given on packing only, provided this information is not required on each article by national authorities);

The number of this International Standard (may be given on packing only, provided this information is not required on each article by national authorities).

Sealing Rings

Sealing rings shall be marked with at least the following information:

Manufacturer's name or trade mark;

Nominal diameter of ring;

Manufacturing information, in plain text or in code, providing traceability of the production period to within the year and month and the production site if the manufacturer is producing at several national or international sites.

1.10. TESTING AND COMMISSIONING**1.10.1. GI& PPR WATER PIPES**

All water distribution system shall be tested whole or in part to 2 times the working pressure with a minimum test pressure of 90psi. The SUB-Contractor shall pay for all device, materials, supplies, labor 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.

- 1.10.2. After all the pipes and fixtures have been properly laid and tested, they shall be flushed with clean 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.

1.11. SOIL, WASTE, VENT & RAIN WATER DRAINAGE PIPES & PIPE FITTINGS (C. I.&uPVC)

- 1.11.1. 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 3-meter head of water. After filling this CONTRACTOR shall shut off water supply and shall allow it to stand two hours, under test during which time there shall be no loss or leakage.
- 1.11.2. The CONTRACTOR shall furnish and pay for all devices, materials, supplies, labor and power required in connection with all tests. All tests shall be made in the presence of and to the satisfaction of the Engineer.
- 1.11.3. 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 repaired. Work shall be replaced with new work without extra cost to the Employer. Tests shall be repeated as directed, until all work is proven satisfactory. All fixtures shall be tested for soundness, stability, support and satisfactory operation.

2. FIRE PROTECTION

2.1. SCOPE

The work to be done under this section of the Specifications includes furnishing all plant, labor, equipment, appliances and materials and in performing all operations required in connection with the supply and installation of galvanized steel pipes and fittings for firefighting system, portable fire extinguishers, fire hose rack cabinets and landing valves as shown on the Drawings, as specified herein and/or as directed by the Engineer.

2.2. APPLICABLE STANDARDS

MS Pipe (Schedule 40)	ASTM A106 Grade B
Portable Fire Extinguishers	BS- 5423
HDPE Pipe	PN-16/SDR-11 DIN 8074/8075

Portable fire extinguishers shall conform to NFPA (National Fire Protection Association) of USA or F.O.C. (Fire Offices Committee) of U.K. and B.S. 5423.

2.3. SUBMITTALS

The CONTRACTOR shall submit technical brochures and samples of all the items mentioned in the Specifications from approved manufactures or as directed by the Engineer.

2.4. MATERIAL

2.4.1. Pipes

(A) MS Pipes (Seamless)

The MS Pipes shall conform to ASTM A160 Grade B schedule 40. Every tube shall be tested at manufacturer's works to specified hydraulic test pressure and shall 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.

A tube shall be effectively covered with good quality grease or other suitable compound, and each tube above 50mm nominal bore shall have a protecting ring affixed to the un-socketed screwed end.

(B) PE Pipes (HDPE)

The PE pipes shall conforming to DIN 8074 specification. Sizes will be 110 & 160mm – PN16.

2.4.2. 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.

a. 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 operated the discharge time for 10 lbs. carbon dioxide extinguisher shall not be less than 9 seconds.

b. 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 use. 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 extend 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 cartage attached to the body of the extinguisher. The operation of the knob or lever shall pierce the cartage to obtain the expellant pressures. When operated the discharge time of 10 lbs. dry powder extinguisher shall not be less than 9 seconds.

c. Water Extinguisher

Water extinguisher shall contain specific quantity of water. The extinguisher shall have a knob or a lever operated valve, a short length of hose and a nozzle at the end. The valve shall have a safety pin to prevent accidental release of the extinguishing agent. The discharge pressure shall be obtained from pressurized carbon dioxide cartage attached to the body of the extinguisher. The operation of the knob or lever shall pierce the cartage to obtain the expellant pressures. When operated the throw for 2 gallons water extinguisher shall not be less than 6 metres. The discharge time shall not be less than 10 seconds.

243. FIRE HOSE CABINET

Fire Hose Cabinet shall consist of rubber hose of specified diameter and length as shown on the applicable drawings. The hose shall have polished brass valved nozzle at one end. The reel shall turn full 180 degrees. Hose and reel shall be placed in a steel or concrete fire box with glazed steel door. The door shall open

full 180 degrees and shall be provided with locking arrangement. The locking arrangement will be such that the cabinet can be opened either by breaking the front glass and turning, the handle from inside or with key from outside without breaking the front glass. The exposed front face of fire hose cabinet shall be painted with signal red enamel paint over a prime coat of anti-corrosive paint. Instructions for opening of fire hose cabinets and operation of hose reel shall be inscribed in signal red on the inside face of the glass such that the instructions can be read from outside.

The hose shall be rated for a working pressure of 16 kg/cm² and test pressure of 25 kg/cm².

25. DELIVERY & STORAGE

Portable fire extinguishers shall be delivered and stored as per manufacturer's directions or as directed by the Engineer while observing all necessary precautions.

26. EXECUTION

26.1. PORTABLE FIRE EXTINGUISHERS

Portable fire extinguishers shall be installed at one meter height above finished floor. Where only extinguishers are installed they shall be fixed to wall or column with painted steel clamps or stored in steel or concrete fire extinguisher cabinets as shown on the applicable drawings or as directed by the Engineer. Where clamped to the wall/column the clamp shall be such that extinguisher can be conveniently fixed and removed without loss of time.

Where stored in cabinets, the cabinets shall be of steel or concrete with glazed steel door painted with at least two coats of anti-corrosive signal red enamel paint over a prime coat of red oxide paint. The locking arrangement will be such that the door can be opened from inside by breaking the glass and from outside with key.

Portable Fire extinguishers shall be painted with color code according to British Standard specifications. On the body of the extinguishers shall be marked/imprinted the following information:

- a. Instructions on how to use the extinguisher.
- 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
- h. Validity/ expiry date

262. Fire Hose cabinet

Fire Hose Cabinet shall be installed at one meter height above finished floor level. The fire hose shall be connected to fire/or potable water system as the case may be, through a Hydrant valve. The valve shall be rated for a working pressure of 16 kg/cm².

If the pressure at the valve exceeds 6 kg/cm² then an orifice plate shall be installed between the gate valve and the fire hose so that the water pressure in the hose shall not exceed 6 kg/cm² under any condition.

2.7. TESTING & COMMISSIONING

The fire water line shall be tested at 1.5 times the working pressure but at a pressure not less than (20 to 150PSI).

3. PUMPING MACHINERY

3.1. SCOPE

The work to be done under this section of the specifications includes furnishing all plant, labor, equipment, appliances and materials and performing all operations required in connection with the installation of pumping machinery including all accessories as specified herein or shown on the Drawings or as directed by the Engineer.

3.2. MATERIALS AND PRODUCTS

Materials and machinery shall conform to the latest referenced specifications and other provisions specified herein and shall be new and unused. In case where manufacturers are specified, material and equipment will be of the same manufacturers. In all other cases the CONTRACTOR shall submit the names and addresses of the Manufacturers and trade names of the materials and equipment that he intends to buy. Other information such as diagram, drawing and descriptive data will be supplied if so desired by the Engineer. Approval of materials and all the machinery under this provision shall not be construed as authorizing any deviations from the specifications. The approval of machinery of manufacturer other than specified will be purely on the discretion of the Engineer. The Engineer will fully ascertain the facts and satisfy himself as to the performance of the machinery offered by the CONTRACTOR.

3.3. SPECIAL REQUIREMENTS OF PUMPS

The CONTRACTOR shall furnish with each pump properly identified characteristic curves prepared and certified by the manufacturer showing capacity, head, efficiency and brake horsepower throughout the entire range of the pump.

The pumps shall stable throttling curves and be suitable for unrestricted parallel operation.

The pumps and their drives shall not overload or trip when operating against zero pressure. The design, construction and materials shall be such that damage as a result of cavitation is completely eliminated.

Pumps shall have bearings and be suitable for continuous as well as intermittent operation without external sealing or cooling water.

The pumps shall be such that they shall come into operation at once after a prolonged shutdown period without having to take special measures.

Pumps shall be capable of delivering specified quantity of water at the specified pressure. Pumps shall be tested at site before their final acceptance.

Pumps shall be installed at positions shown on the Drawings and/or as directed by the Engineer.

Pumps and their drives shall be in perfect alignment when installed in position.

3.4. PUMP AND MOTOR

3.4.1. POTABLE WATER PUMP & MOTOR

3.4.1.1. Specifications

The pump sets will consist of close coupled, horizontal, centrifugal pumps of specified capacity and head and duty and shall be horizontally mounted totally enclosed, fan cooled, squirrel cage induction motors of specified power

Pump material shall be as under:

Body : Fine grained grey cast iron

Impeller : Bronze

Shaft : Bronze or stainless steel

Pumps shall have mechanical seal. The suction and discharge flanges shall be rated for a working pressure of 10 kg/cm² for potable water pumps. The flanges shall be drilled to BS 19 (Table 'D' or 'E') or BS 4504.

Motors shall run on 3-phase, 400 volts \pm 10%, 50 c/s NC power motors shall be protected from low voltage, overload, overheating and phase failure.

3.4.1.2. Installation

Potable water pumps and motors shall be installed on concrete foundation with anchor bolts.

3.4.1.3. Operation

For potable water pumps, one pump shall be duty and one shall be standby. Duty shall however change between the pumps on each start/stop/cycle of the pump.

Operation of potable water pumps shall be controlled by water level indicators provided on the roof tank of the building.

Duty pumps shall automatically start, when the water level reaches the low water level (L.W.L).

Duty pumps shall automatically stop when the water level reaches high water level (H.W.L).

Duty pumps shall automatically stop when the water level in the underground tank reaches the low water level (L.W.L).

In case the duty pumps fail to start, the stand by pump shall start automatically. In case the stand by pump also fails to start, the emergency alarm will be automatically sounded.

3.4.2. FIRE WATER PUMP & MOTOR

The pump sets will consist of close coupled, horizontal, centrifugal pumps of specified capacity and head and duty and shall be horizontally mounted, totally enclosed, fan cooled, squirrel cage induction motors of specified power. Pump materials shall be as under:

Body	:	Fine grained grey cost iron
Impeller	:	Bronze
Shaft	:	Stainless steel
Shaft Sleeve	:	Bronze or stainless steel

Pumps shall have mechanical seal. The suction and discharge flanges shall be rated for a working pressure of 16kg/cm² for fire pumps. The flanges shall be drilled to BS 10 (Table 'D' or 'E') or BS 4504.

Motors shall run on 3-phase, 400 volts + 10% 50 c/s A/C power motors shall be protected from low voltage, overload, and overheating and phase failure.

3.4.2.1. Installation

Fire water pumps and motors shall be installed on skid land connects will be concrete foundation with anchor bolts.

The motor control panel shall be located in the pump house in a painted steel cabinet with locking arrangement. The panel shall be wired to each pump by water proof power cable.

3.4.2.2. Operation

For main fire water-pumps, one pump shall be duty and one shall be standby. Duty shall however change between the pumps on each start/stop/cycle of the pump.

There shall also be a jockey pump installed in the system which shall start automatically before main fire water pumps, to account for any accidental use of FMC or leakage in the system. This jockey pump shall have the capacity to turn off automatically when accidental fault is over and the desired pressure is achieved. Main pumps shall operate automatically only at indicated pressures when demands are more to fight a fire in reality. However, main pumps shall stop manually when the fire is over.

3.4.3. Submersible Drainage Pump with electric motor

Pump shall be submersible centrifugal type with horizontal or vertical discharge port designed for free standing installation or installation by means of an auto-coupling guide rail system or for pit installation. The pump housing shall be stainless or cast iron steel. The stainless steel pump sleeve shall be in one piece

and equipped with an insulated carrying handle. The suction strainer shall be clipped on to the pump housing so that it could easily be removed for maintenance. The stainless steel pump housing shall be fitted with an internal riser pipe ensuring that has a number of holes which enable efficient cooling of the motor during operation. The cable entry shall be of the socket and plug connection type.

The shaft shall be stainless steel which shall rotate in maintenance-free heavy duty pre-lubricated ball bearings. The impeller shall be of stainless steel. The impeller shall be semi-open type with L-shaped blades. The blades shall be curved backwards. The unit shall be equipped with at least 10m standard water-proof power cable. The operation of the pumps shall be controlled automatically by means of level switches. Pump shall be vertical, single entry, single or multi stage.

Pumps capacity and head shall be as specified in schedule of pumps.

Pumps shall be installed as shown on drawings.

Pumps shall be supplied and installed complete with Electric motor, starter, control panel, level switches, etc.

3.5. ACCESSORIES

3.5.1. PRESSURE GAUGE

Pressure gauge shall be of copper alloy, bourdon tube type with 100 mm diameter dial face. The dial shall be engraved in black on white background from zero to 6 bars or 1.5 times the working pressure whichever is larger. Gauge shall be installed socket welded to the pipeline with the isolating plug/ball valve. Gauge shall be installed no higher than 1.8 M above the finished floor. If the pipeline installation is such that the above requirement cannot be met pressure gauge of remote reading type shall be installed.

3.5.2. Y-STRAINERS

Strainers shall be 'Y' types with bronze body and threaded ends upto 75mm diameter Screen shall be of 20 mesh monel. Strainers above 75 mm shall have Cast Iron body with flanged ends. Screen Cover shall be provided with blow off tapping. Screen shall be of perforated stainless steel, 36 holes per Sq.Cm., with 1.14 mm diameter and 0.5 mm thick. All strainers for water supply application shall be suitable for 10.5kg/Cm² and 120 degree C. All strainers for fire protection service shall be suitable for 21 Kg/Cm² and 120 degree C.

3.5.3. FOOT VALVE FOR PUMPS

Shall be installed on the suction Line of the pumps where required or indicated on the drawing: Foot valve shall be of brass, and shall be provided with integral

strainer. Foot valve shall be provided with a spring loaded vertical check disc with gasket for tight shut-off.

3.6. MOTOR PROTECTION

Motors of 3kw or less power shall be started direct on line. Larger motors shall be started by Star-Delta Starter.

Motor shall be protected against under voltage over voltage overload, over-heating and phase failure.

Motor shall be rated for normal operation against a voltage fluctuation of +10% and frequency fluctuation +2HZ.

3.7. MOTOR CONTROL PANEL

Refer to relevant electrical specifications and drawings

3.8. MAINTENANCE MANUALS AND TOOLS

- 3.8.1. A book or books containing the complete information in connection with the assembly operation, lubrication, adjustment and repair of the pumping equipment, electric motor, together with the detailed part with the drawings or photographs shall be furnished in duplicate.
- 3.8.2. For the pumping station, special tools necessary for maintenance and repair of the pumps and electric motors including tools kits, grease guns etc. with accessories shall be furnished.
- 3.8.3. The equipment to be supplied for the pumping station shall be provided with spare parts necessary to the operational and maintenance for 1 year.
- 3.8.4. The manufacturer's recommended list of spare parts to be stocked by the Authority shall be submitted by the CONTRACTOR to the Engineer for approval. Such spare parts will also be furnished by the CONTRACTOR.
- 3.8.5. AU the maintenance manuals, tools, spare parts etc., shall be supplied by the CONTRACTOR at no cost of the Authority and all cost shall be deemed to be included by the CONTRACTOR in his bid against item of pumping set.

END OF THE SECTION

TENDER DOCUMENTS (VOLUME-III)
TECHNICAL SPECIFICATIONS (ELECTRICAL WORKS)

TECHNICAL SPECIFICATIONS ELECTRICAL WORKS

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SECTION - 1 TECHNICAL PROVISIONS**TP.1 GENERAL.**

The general instructions are given to the tenderers elsewhere in this contract document. The additional instructions in the following paragraphs are given in order to invite the tenderer's attention towards some major points pertaining to electrical work only and to assist them in preparing tenders. These instructions shall be deemed as Technical provisions of the Contract.

TP.2 SCOPE OF WORK.

The work consists of furnishing all tools, plants, labor, materials and equipment and performing the internal and external electrical works comprising of the following or as specified in Schedule of Values.

SECTION - A	H.T. Switchgear & Transformer.
SECTION - B	L.T. Switchgear Main Panel Board and DB's.
SECTION - C	Internal Wiring Concealed with PVC Conduit.
SECTION - D	Fitting & Fixtures.
SECTION - E	Cables, Conduits, Cable Trays & Rising Mains.
SECTION - F	Emergency Diesel Generating Set.
SECTION - G	Voice Data Systems.
SECTION - H	Fire Alarm System.
SECTION - I	M.A.T.V System.
SECTION - J	Music & Paging System.
SECTION - K	Lightning Protection System.
SECTION - L	Earthing System
SECTION - M	Closed Circuit Television System.
SECTION - N	Miscellaneous Items.

The work shall be carried out in strict accordance with the conditions of contract, special conditions, Drawings, Technical Specifications, in coordination with other CONTRACTORS on this project and as per items of Schedule of values and including the responsibility of all related works necessary for their proper functioning, testing, commissioning and satisfactory operation and performance including maintenance for the period specified elsewhere. The CONTRACTOR shall provide for all required technical non-technical personnel, skilled and non-skilled labour, construction equipment, transportation etc., as required for the completion of works in strict accordance with the Technical specifications laid here-in after.

TP.3 **CONTRACTOR'S QUALIFICATION.**

The Electrification work shall be carried out only by a licensed CONTRACTOR authorized to undertake such work under the provisions of the Electricity Act, 1910, and the Electricity Rules, 1937, as adopted and modified by the Government of Pakistan.

TP.4 This licensed Electrical CONTRACTOR shall have the following qualifications.

- a. Must have in his employment a competent graduate Electrical Engineer registered with Pakistan Engineering Council, Islamabad.
- b. Must possess a valid Electrical licence issued by the Electrical Inspector of Islamabad region.
- c. Must have in its employment an Electrical Supervisor having certificate of competency who will exclusively look after this work.
- d. Must have necessary tools, plant and instruments.
- e. Must have adequate experience of similar works.

TP.5 **RULES AND REGULATIONS**

The installation in general shall be carried out in conformity with the Electricity Rules, 1937, and the latest edition of the Regulations for the electrical equipment of buildings issued by the Institution of Electrical Engineers London (I.E.E.) However, in case of conflict between these specifications and the I.E.E. Regulations, these specifications supercede IEE regulation.

TP.6 **STANDARDS**

The latest relevant British specifications and codes, Pakistan Standard Specifications, VDE, I.E.C. and I.E.E. recommendations shall be applicable and be followed for the equipment specified herein.

TP.7 **CLIMATIC CONDITIONS**

All equipment supplied shall withstand, without developing any defect, the following climatic conditions.

Maximum Ambient Temperature = 120°F or 49°C

Minimum Ambient Temperature = 28°F or -2.2°C

Maximum Humidity = 90 %

TP.8 **SPECIFICATIONS**

The CONTRACTOR shall furnish all material and equipment at site, conforming fully to the specifications given herein and to the accepted standards as laid down by British Standards, the Institution of Electrical Engineers, London, and the Pakistan Standard Institution. It is not the intent of these specifications to include all details of design and construction of various material and equipment to be supplied under this contract. The CONTRACTOR shall supply and install all material and equipment specified herein and also all installation and small material such as nuts, bolts, washers, shims, angles, leveling material, installation as covered by the specifications.

All material and equipment supplied by the CONTRACTOR shall be new and in all respects conform to the high standard of engineering design and workmanship, perform and function as herein specified and fully meet the quality level and ruggedness requirement of the specifications. All material and equipment which have to be supplied and installed by the CONTRACTOR shall be passed / approved by the Engineer; even if the same is exactly in accordance with the Schedule of values and drawings.

TP.9 **SUBMITTAL**

The CONTRACTOR, after the award of work, shall submit for approval of the Engineer all drawings and Catalogues of equipment, appliances, fixtures and accessories that are to be furnished under the contract. After final approval of a sufficient number of copies as desired shall be furnished for distribution. Catalogues

and drawings shall be clearly marked to indicate, the items furnished. Catalogues of all fixtures, and not a few, shall be submitted.

TP.10 **APPROVAL OF DRAWINGS AND DATA**

The CONTRACTOR shall provide detailed electrical drawings, wiring diagrams, foundation details, etc., for all electrical switchgear, fuse-gear and all other systems etc., for the Engineer's review for obtaining approval.

The manufacturing of electrical equipment shall be started only after the above mentioned drawings and data are approved.

The time required for review and approval shall be considered included in the total time of completion of job.

TP.11 **DRAWINGS AND DATA**

Three sets of drawings and data for each equipment shall be furnished by the Sub-contractor for the Engineer's approval before commencement of fabrication and manufacture which would start only after that approval. The drawings to be supplied by the CONTRACTOR shall be as follows:-

- Arrangements.
- Dimensional Plans, elevations and front view.
- Foundation Plan, anchors and configuration.
- Incoming and outgoing cable termination positions.
- Earthing arrangement.

Electrical Drawings showing.

- One-Line diagram.
- Detailed wiring diagram.
- All interconnections.
- Instrument transformers.
- Relays, their locations and internal wiring diagrams.

- Other electrical devices including meters instruments and their wiring diagram.
- Signal and alarm circuit.

TP.12 **SHOP DRAWINGS**

The design drawings show approximate conduit routes and depict only the position of various fixtures and outlets. All the actual planning for the conduit routes shall be carried out, well in advance of the actual execution of work, by the CONTRACTOR to the satisfaction of the Engineer. For this purpose the CONTRACTOR shall prepare shop drawings and obtain prior approval of the Engineer. Three prints of each shop drawings shall be submitted for obtaining approval.

No piece of work shall be allowed to be executed at site without the availability of these approved shop drawings. These shop drawings shall clearly depict the load balancing chart of each distribution board. Time required for the preparation and approval of shop drawings shall be considered to have been included in the total time allowed for the completion of the work.

TP.13 **SETTING OUT OF WORK**

The CONTRACTOR shall set out the work himself and if any discrepancy is found, he shall report the matter to the Engineer and shall act as directed. If any defective or modified setting out is carried out by the CONTRACTOR on his own, he shall rectify or make it good at his own cost.

TP.14 **PROGRAMMING**

The CONTRACTOR shall keep pace with the work of the Civil CONTRACTOR and any other specialist CONTRACTOR. The engineer shall be kept informed about the programme and the progress of work so that there is no hindrance in the execution of work at site.

TP.15 **PROTECTION**

The CONTRACTOR shall take care not to damage the structure , material, equipment and property belonging to and/or installed by other CONTRACTORS during execution of work and shall repair and make-good all losses at his own cost, if found damaged in the opinion of the Engineer.

TP.16 CHANGE OF SPECIFICATIONS.

No change in specification of the equipment / material will be allowed at any stage, except with the prior approval of the Engineer before the opening of Tenders.

TP.17 PURCHASE OF EQUIPMENT / MATERIAL.

All the equipment and material e.g. transformers, switchgear, cables, conduits, light fixtures and fans etc. will be purchased direct from the manufacturer. Certificate and copies of delivery challans for all such material will be produced as and when desired.

TP.18 MANUFACTURERS AND BRANDS.

Where brands and names of Sub-Station equipment or any other system are specified by name, alternative can be offered provided these are equal in quality to those specified. Satisfaction of the Engineer in this respect shall be essential and prior approval for such deviation shall have to be obtained before submission of Tenderers. However all equipment for substation or system shall be from one manufacturer only.

TP.19 FACTORY TESTS

All routine and type tests on HT LT switchgear (ACBs, MCCBs , Relays , Magnetic Contactors , PFI Equipment and Enclosures), HT & LT cables , Emergency Diesel Generating Sets and other equipment shall be performed at the manufactures facility or at a recognized independent test laboratory in the presence of the “Engineer” as per applicable international standards .The term “Engineer” henceforth in the rest of the technical specification of electrical works shall mean an assigned, qualified electrical engineer of Client and Consultant. The presence of both engineers shall be ensured at all times during factory tests and inspection. The sub-contractor shall be allowed to supply equipment to site only after successful and satisfactory testing and inspection at factory / laboratory with 3 copies each of test reports dully issued to be maintained in client’s and consultant’s record. The sub-contractor shall inform the engineer about the date and time of tests on each equipment at least two weeks in advance. The witnessing of tests by the engineer shall not absolve the CONTRACTOR of his responsibility for proper functioning of the equipment , and for furnishing the guarantee. CONTRACTOR shall at its own expense make all arrangement of transportation loading etc for the engineer, without any claim of addition charge or cost to the client for tests and inspection.

TP.20 OWNER'S SUPPLIED MATERIAL.

Material and equipment if supplied by the Owner shall be made available at site store to the CONTRACTOR for installation. Any lead and lift upto and within the site of work shall be at the cost and responsibility of the CONTRACTOR . The sub-contractor shall ensure safe handling and proper protection after the material and equipment are issued to him at site store and shall provide and maintain required plant and equipment for handling, proper protection and installation at his own cost.

TP.21 SPARE PARTS LIST

A list of spare parts required for one year's operation of each equipment where deemed necessary "except OFM" together with unit price of each part, shall be supplied by the CONTRACTOR.

TP.22 GUARANTEE

The CONTRACTOR shall furnish written guarantee, in triplicate, of the manufacturer for successful performance of each equipment. Such guarantee shall be of material and / or workmanship. The guarantee shall cover a minimum period of 12 months effective from the date of completion certificate.

TP.23 AS-BUILT DRAWINGS.

The CONTRACTOR shall, during the progress of work keep a careful record of all changes and revisions where the actual installation differs from that shown on shop drawings. These changes and revisions shall be accurately carried out on the shop drawings and submitted to the Engineer for approval. After approval these drawings shall become the property of the Owner. These updated and approved shop drawings depicting clearly As-Built drawings shall be submitted to the Engineer. Reproducible tracings of all these As-Built drawings shall be handed over to the Engineer. Final payment will be withheld until the receipt of the approved As-Built Drawings.

TP.24 TEST REPORTS.

The CONTRACTOR shall be responsible for submitting the test reports/ certificates and get the installation inspected / passed by the Regional Electric Inspector at his own cost.

TP.25 PESCO REQUIREMENT.

The CONTRACTOR shall assist the Owner in sponsoring application for Electrical Connection, with PESCO and carry out necessary formalities. Any special

requirement of PESCO shall be complied with by the CONTRACTOR. The Owner shall arrange to deposit all amounts, on demand, to PESCO for providing service connection and security deposits thereof.

TP.26 **T & T REQUIREMENT.**

For the supply, installation and regularization of Telephone system, the sub-contractor shall obtain N.O.C. from Director General, T&T Department, Ministry of Communications, Govt. of Pakistan, Islamabad if required. Any special requirement of the T&T Department shall be complied with by the CONTRACTOR . The Owner shall arrange to deposit all amounts on demand from T&T Department for obtaining telephone connections to public Exchange and security deposits etc.

SECTION – 2 PVC CONDUITS AND ACCESSORIES

2.1 SCOPE

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

2.2 SUBMITTALS

Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items. Show the following:

2.3 MATERIALS

A. CONDUIT PIPE

The conduit for wiring of circuits, lights, socket outlets and other systems shall be made of PVC manufactured under the trade names of "Polo" or "Popular" conforming to BS6099.

Steel conduit shall conform to BSS 31/latest and shall be 'International', Hilal and/or Premier "brands. The conduit shall be enameled with good quality non-cracking and non-flaking black paint.

B. FLEXIBLE PIPE

Flexible conduit shall be furnished and installed where necessary for convenient dismantling and/or avoiding vibrations to be transmitted. Flexible conduit shall be spiral interlocked type made of steel strip construction and coated with zinc or chromium plated.

C. CONDUIT ACCESSORIES.

Factory made round PVC. junction boxes shall be installed with non pressure type Pvc conduits. Junction boxes shall be of 2-1/4" dia and 3" long to receive Pvc conduit and shall be concealed in RCC of slab. The wall type junction box shall also be factory made round PVC boxes having minimum dimensions of 2-1/4" dia and not less than 1-1/4" long. Each junction box shall be provided with one piece cover which shall be fitted on the box with chromium plated screws.

- a. Conduit accessories such as switch boxes, socket outlet boxes, pull boxes and inspection boxes shall be made of 16 SWG sheet steel having dust tight covers. All boxes shall have required number of conduit entry holes and earth terminals for connecting E.C.P. All the rectangular or square

shaped boxes shall have nipples to receive PVC conduit with force fit. All these boxes shall be painted inside and outside with black enamel, over a base coat of red oxide antirust paint. Shapes and sizes of these boxes shall be determined on each application.

- b. Manufactured smooth bends shall be used where conduit changes direction. Bending of conduit by heating or otherwise shall be allowed only at special situations with the permission of the Engineer. Use of shape 90 degree bends and Tees is prohibited. Bends shall have enlarged ends to receive the conduit without any deduction in the internal diameter of the PVC pipe.
- c. All accessories e.g. boxes, couplings, bends, solid plugs, bushes, reducers, checknuts etc. shall be equal in quality to the specified conduit.
- d. Where inspection boxes occur in floor slabs a special cover on the box shall be installed to the satisfaction of the Engineer.
- e. The use of looping in box shall be allowed in places where floor slab thickness permits 90 degree bends in conduit.

EXECUTION

The CONTRACTOR shall furnish all labour and material for the installation of conduit as required.

- 24.1. Conduit shall be installed concealed in RCC ceiling slabs, columns, walls and floors etc., Recessed conduit shall be laid over the first tier of reinforcement and under the second tier of reinforcement before pouring of concrete. All conduit outlet boxes to be concealed shall be laid firmly flush with the soffit of the slab or beam. The conduit should be tied to the reinforcement firmly so that the alignment is not disturbed by vibrators. All the outlet boxes installed shall be stuffed and their cover plates fixed so as to prevent concrete entering the outlet boxes.
- 24.2. Under no circumstances shall chasis be made for recessing conduit in the RCC structure after it has been cast without the permission of the Engineer. Where conduits have to be concealed in cement concrete or brick masonry, chasis shall be made with appropriate tools not deeper than required. The conduit shall then be fixed in the chasis with iron hooks before covering it up with at least 20mm thick plaster. Conduit ends pointing upward shall be properly sealed to avoid entry of foreign material.

243. The drawings show conduit routes but planning for proper arranging conduit routes shall be carried out by the CONTRACTOR to the satisfaction of the Engineer.
244. The entire conduit system shall be essentially completed before the wire pulling is taken in hand. Each conduit run shall be tested for continuity and obstructions. All obstructions shall be cleared in an approved manner. Water and moisture that has entered any section of the conduit installation must be dried with suitable swabs to the satisfaction of the Engineer.
245. Adequate expansion joints shall be provided in all conduit runs passing across the expansion joints in the concrete slabs of the buildings. A typical arrangement is shown on drawing.
246. Pull boxes shall be installed in conduit runs at intervals mentioned below to facilities the pulling length of wires:-
- | | | | |
|------|---------------------------------|---|-----------|
| i) | Straight runs. | - | 20 meter. |
| ii) | Runs with one 90 degrees bends. | - | 15 meter. |
| iii) | Runs with two 90 degrees bends. | - | 10 meter. |
247. Conduit runs between two outlets shall not contain more than two quarter bends or one 90 degree bend.
248. All the free ends of conduit shall be solidly plugged till such time as final and proper terminations are made.
249. All conduits of a system shall be run at least 6" away from the other systems and services where conduit of one system crosses the other it shall be done so at right angle i.e. 90 degree.
2410. All multiple runs of conduit shall be arranged symmetrically.
2411. Exposed runs of conduit where required shall be firmly held by means of G.I. saddles, clamps and brackets etc., to the surfaces of walls, columns and ceiling. Rawal plugs or phil plugs may be used for fixing saddles, clamps and brackets etc. The spacing between two saddles may not be more than 30". The straight runs on walls may be 18" to 24" below the ceiling and in the event of any obstruction due to beams the runs may be routed them. The conduit shall have a minimum clearance of 6 mm

from the surface supporting it. Purpose made special clips and brackets may be required at some situations to support the conduit.

- 2.4.12. No conduit less than 20mm dia. shall be used for point wiring and 25mm dia. for power wiring. The size of conduit shall however be determined from the number of wires required in the conduit run according to number of wires allowed as per IEEE Regulations.
- 2.4.13. Use appropriate size sleeves for crossing of beams lintels retarding walls etc. for providing conduits / cables at later stage.

APPLICATION

- A. Outdoors - General:
1. Exposed: PVC
 2. Concealed: PVC
 3. Underground, PVC SCHEDULE 80
 4. Boxes and Enclosures: NEMA 250, Type 3R.

2.5. JOB CONDITIONS

- 2.5.1. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
- 2.5.2. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
- 2.5.3. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer

SECTION – 3 WIRES, CABLES AND CORDS.

3.1 SCOPE

The wires & cords for conduit wiring shall be single core, made of stranded copper conductors, PVC insulated, tested to B.S. 6004, 1975. The voltage grade shall be 300/500 volts or 450/750 V unless otherwise specified on drawings and Schedule of values. The cables shall be of M/s. Pakistan Cables Limited, M/s. PIONEER Cable, M/s. Newage Cables.

3.2 MATERIALS

In order of preference as approved by the Engineer. The size of the wire shall be as follows:

- i) for light or fan point wiring with 1.5MM square (or 3./029) or as specified in the SCHEDULE OF VALUES.
- ii) for light circuit wiring with 2.5MM square (or 7/0.29) or as specified in the SCHEDULE OF VALUES.
- iii) for power plug 15A wiring with 4 MM square (or 7/.036) or as specified in the SCHEDULE OF VALUES.
- iv) the sizes of cables from Main Panel Board to Sub-Main Panel board to distribution boards shall be as shown on drawings or as specified in SCHEDULE OF VALUES.

3.3 EXECUTION

- 3.3.1 The CONTRACTOR shall furnish all material and labour to pull in and install wires and cables as required. The CONTRACTOR shall also supply, without extra cost, wire accessories e.g. plugs, solder, clamps, supports, bushes, fixing pins, adhesive tapes, connectors, identification tags, straps, filling compound and earthing clips etc. as are required to be furnished for complete wiring installation in accordance with standard practice. The pulling of wires shall be taken in hand only when all conduit system is complete. All termination shall be mechanically strain free and electrically sound.
- 3.3.2 The wiring of the installation shall be strictly in accordance with the scheme, cable sizes and circuit details as shown on drawings and specified in WCC.1

- 3.3.3 All wiring shall be continuous between terminations and use of connectors or joints disallowed. Spur and Tee connections are strictly prohibited. Looping in system shall be followed throughout.
- 3.3.4 Manufacturers recommended lubricant shall be allowed to facilitate pulling of wires, use of all other kind of oil and soap is prohibited.
- 3.3.5 All wires occupying the same conduit shall be pulled together. Wires and cords at the time of pulling shall not be subjected to a bending radius more than 10 times the overall diameter of cables. Cable manufacturer's recommendation of pulling speed and pulling tension on cables shall govern the pulling operation.
- 3.3.6 Not more than 2 circuit wires shall be bunched in the same conduit. Wires of two different phases, however, shall not be run or terminated in the same outlet box for single phase wiring of lights, switches and sockets.
- 3.3.7 Porcelain or molded plastic connectors shall be provided for a joint between light point wiring and light fixture wiring and housed in the outlet box provided for this purpose. The CONTRACTOR after terminations are made shall be wrapped in PVC insulation tape.
- 3.3.8 The quantity and the size of the wire contained in any one conduit shall not be in excess of the numbers permitted by I.E.E. regulations.
- 3.3.9 All point and circuits wiring shall be solidly earthed by 14SWG (2.5mm square) PVC insulated wire of color Green, Yellow to serve as CPC which shall be run inside the conduit.
- 3.3.10 All 5A & 15A socket shall be wired separately direct from D.B. without any claim of circuit and distinctly from light point wiring, or as specified in SCHEDULE OF VALUES. However 5 Amps socket shall be controlled by D.B, or as specified in SCHEDULE OF VALUES.

SECTION – 4 WIRING ACCESSORIES

4.1. SCOPE

A. This Section includes the following:

1. Single and duplex receptacles, and ground-fault circuit interrupters.
2. Single- and double-pole switches and dimmer switches.
3. Device wall plates.
4. Floor service outlets and multi outlet assemblies.

4.2. SUBMITTALS

- a. Product Data: For each type of product indicated.
- b. Shop Drawings: List of legends and description of materials and process used for pre marking wall plates.
- c. Field quality-control test reports.

4.3. MATERIALS

4.3.1. SWITCHES

- a. Indoor switches controlling lights and fans shall be single pole, 10A, one or two way, suitable for 250V, 50Hz. The body of the switches shall be made of moulded plastic, one, two, three, four or six gang with integral built in moulded plastic face plate suitable for fixing on a sheet steel outlet box. The switch contacts shall be silver alloy tipped and these shall operate with snapaction. The switches shall be piano type, ivory white in colour. The switches shall conform with BSS 800.
- b. Weather proof switches on external lighting circuits shall be rotary type with quick make quick break action rated 5/10 Amps, 250 V, 50 Hz.

4.3.2. SWITCH SOCKET OUTLET UNITS

- a. Switch and socket units shall be single pole, 3 pin rated 13A or 15A, 250V, 50 Hz. These shall be moulded plastic type with ivory white integral built-in face plate. Each socket shall have its control switch by the side of it on a common face plate. Thus the complete unit specified in SCHEDULE OF

VALUES shall be as switch and a socket outlet unit. The switch socket outlet unit shall comply with BSS 546 and BSS 5733 or BSS 3052. Bells / chimes/Buzzers and bell pushes shall be suitable for operation on 230 Volts

- b. Weather proof switch units shall have a cast iron outlet box with threaded conduit entry holes or nipples, rubber gasket and a spring loaded sheet steel cover.
- c. Ceiling roses shall conform to BSS 67/1969. Lamp batten holders shall conform to BSS 5042 Part-I.

EXECUTION

All the switches and switch socket outlet units shall be installed on 16 SWG thick sheet steel outlet boxes of appropriate sizes All sheet steel boxes shall have conduit entry and terminals for connecting 14 SWG or 2.5mm (sq) PVC insulated circuit protective conductors.(CPC)

- A. Install devices and assemblies level, plumb, and square with building lines.
- B. Install equipment in accordance with manufacturer's installation instructions.
- C. Define each dimmer's load type, assign each load to a zone, and set control functions.
- D. Provide equipment at locations and in quantities indicated on drawings. Provide any additional equipment required to provide control intent.
- E. Perform full-function testing on all completed assemblies. Statistical sampling is not acceptable.
- F. Install wall dimmers to achieve indicated rating after derating for ganging according to manufacturer's written instructions.
- G. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' written instructions.
- H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates where possible.
- I. Remove wall plates and protect devices and assemblies during painting.

- J. Adjust locations of floor service outlets to suit arrangement of partitions and furnishings.

4.5. IDENTIFICATION

- 1. Receptacles: Identify panel board and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.
- 2. Switches: Where three or more switches are ganged, and elsewhere as indicated, identify each switch with approved legend engraved on wall plate.

4.6. QUALITY ASSURANCE

Source Limitations: Obtain each type of wiring device through one source from a single manufacturer.

After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.

SECTION – 5 POINT WIRING & CIRCUIT WIRING**5.1. SCOPE**

The work included under this Section consists of furnishing all labour, material, services and skilled supervision necessary for the construction, erection, installation and connection of all circuits and equipment specified herein or shown on the drawings and / or normally required for an installation of this type including but not limited to testing of the installation and its handing over to the Owners. The extent of work specified herein and/or shown on the drawing represent the minimum requirements. The installation on the whole should conform to the best form of workmanship and shall be accomplished by workmen, licensed and skilled in this type of work.

5.2. MATERIALS**5.2.1. POINT WIRING.**

For the purpose of measurement of light / fan point wiring the following work shall be deemed to constitute the work of a point wiring:-

- a) Providing and fixing conduit from a switch to wall / column / ceiling outlet, or fan / fixture excluding final sub-circuit conduit from distribution board to the switch as described in section 2 or as specified in SCHEDULE OF VALUES.
- b) Providing and pulling of wires from switch to fan / fixture outlet excluding providing and pulling of final sub-circuit wiring in the conduit laid as in (a) above and as described in Section 3 or as specified in SCHEDULE OF VALUES.

5.2.2. SOCKET OUTLET WIRING.

- a) For 5A socket on the light switch board and also away from the board the basis of the measurement shall be the same as in section 2.1.
- b) For 13A/15A socket outlets the work shall comprise as under:-
 - i) Providing and fixing conduit from distribution board to the socket outlet as described in section 2
 - ii) Providing and pulling of wires in the conduit as in (a) above as described in section 3

5.2.3. CALL BELL POINT WIRING.

This shall be identical to section W.1 i.e. wiring for light point or as specified in SCHEDULE OF VALUES.

SECTION – 6 LIGHT FIXTURES

6.1. SCOPE

Light fixture schedule is provided in the drawings along with catalogue numbers of the manufacturers which are meant to serve as illustrations of the types of fixtures required for various applications.

The CONTRACTOR shall be required to submit samples of each and every light fixture for the approval of the Engineer, before commencing with mass production of the fixtures. The CONTRACTOR should be prepared to carry out any number of modifications and improvements in the submitted sample free of cost until a finally acceptable sample is produced. Mass production shall be taken in hand only after a finished and modified sample has been produced and approved in writing by the Engineer. The CONTRACTOR has the option to offer acceptable equivalent of the specified light fixtures but to be installed with prior approval from Engineer.

This Section includes the following:

1. Interior lighting fixtures with lamps and ballasts.
2. Lighting fixtures mounted on exterior building surfaces.
3. Emergency lighting units.
4. Exit signs.
5. Accessories, including occupancy sensors.

6.2. SUBMITTALS

- A. Product Data: For each type of lighting fixtures, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 1. Physical description of lighting fixture including dimensions.
 2. Emergency lighting units including battery and charger.
 3. Ballast type and ballast factor.
 4. Energy-efficiency data.
 5. Sound Performance Data
 6. Life, initial lumen rating, CRI, CCT, mercury content, and energy-efficiency data

for lamps and ballast system.

7. Photometric data,
- B. Shop Drawings: Show details of nonstandard or custom lighting fixture. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
 1. Wiring Diagrams: Power and control wiring.
 - C. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 1. Lighting fixtures.
 2. Suspended ceiling components.
 3. Structural members to which suspension systems for lighting fixtures will be attached

[including seismic strengthening].
 4. Other items in finished ceiling including the following:
 - a. Air outlets and inlets.
 - b. Speakers.
 - c. Sprinklers.
 - d. Smoke and fire detectors.
 - e. Occupancy sensors.
 - f. Photosensors
 - g. Access panels.
 5. Perimeter moldings.
- D. Samples for Verification: Interior lighting fixtures designated for sample submission in Interior Lighting Fixture/Luminaire Schedule. Each sample shall include the following:

1. Lamps and Ballasts: Specified units installed.
2. Accessories: Cords and plugs.
- E. Product Certificates: For each type of ballast for bi-level and dimmer-controlled lighting fixture, signed by product manufacturer.
- F. Qualification Data: For agencies providing photometric data for lighting fixture.
- G. Field quality-control test reports.
- H. Operation and Maintenance Data: For lighting equipment, controls and fixtures, including emergency, operation, and maintenance manuals.

6.3. MATERIALS

The LED lights fixtures shall be down lighters/light panels/floods lights as shown in drawings and given in SCHEDULE OF VALUES. These will be surface mounted or recessed in false ceiling as per requirement of the project. The light fittings shall be CE/IEC & ROHS approved according to ambient temperature comprising of LED's of having life span of **50,000 hours**. All the light fixtures shall be certified by 3rd party having following certificates

- | | |
|-------------------------------------|----------------------------|
| 1. Lumen Maintenance of LED Source: | IES LM-80-08 |
| 2. Luminaire Fixtures Type Test | IEC 60598 |
| 3. Photo biological Safety: | IEC 62471 |
| 4. EMC Test Report | EN 56100-3-2, EN 61000-3-3 |

LF.1 LED & DRIVER

LED shall be class-I having at least 100 lumens/Watt and make of CREE/EPISTAR/BRIDGLUX/LG/NICHIA or approved equivalent having color shifting SDCM Level of ≤ 5 for indoor light & ≤ 7 for outdoor light. The Driver unit having tolerance range of 110V to 277V with surge protection device & Power Factor PF of >0.9 , total harmonic distortion should be less than 15%. The driver should be MEANWELL or approved equivalent.

LF.2 EMERGENCY LIGHTING

Emergency light fixtures shall be of the self-contained 3-hour maintained/non-maintained type, as specified, with 8 watt high efficiency fluorescent lamp and

prismatic diffuser, with maintenance-free NiCad batteries, separate baseplate, plug-in luminaries with locking screw. The emergency output shall typically be 180 lumens.

Exit sign and other legends, which shall be chosen and approved by the Engineer, shall be to BS formats, 180mm or 90mm high, as required.

Converter systems shall be of the type suitable for mounting within luminaries, to convert an ordinary fluorescent luminaries into a self-contained battery-powered emergency luminaries. The emergency output shall typically be 600 lumens minimum.

6.4. EXECUTION

The light fittings shall be installed according to manufacturer's recommendations or as approved by the Engineer.

1. Flexible connecting wires from outlet box to the fixture shall be provided by the CONTRACTOR; connector made of porcelain or thermoplastic material shall be provided and installed in the outlet boxes for connecting flexible wires to the point wires.
2. Outlet boxes or any openings in the ceilings or walls shall be covered with appropriately fabricated accessories to provide an architectural entity to conceal them.
3. Rawal plugs or nylon plugs with good screws shall be used for fixing purposes.
4. Completely connect and securely mount lighting fixtures. Provide additional supports and hangers as necessary to securely fasten and support lighting fixtures to ceiling or structure.
5. Install lighting fixtures plumb and true, and square with ceilings and walls. Install continuous rows of fixtures such that rows appear as continuous system without visible vertical or horizontal undulation.
6. Hang pendant fixtures plumb, and with no "kinks" in pendants or cable.
7. Install lamps in each fixture.

6.5. QUALITY ASSURANCE

- 6.5.1. Mockups: Provide lighting fixtures for room or module mockups. Install fixtures for mockups with power and control connections.

1. Obtain Project Director/COR's approval of fixture for mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
4. Inspect each installed fixture for damage. Replace damaged fixtures and components
5. Verify normal operation of each fixture after installation
6. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify normal transfer to battery power source and retransfer to normal. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

6.6. EXTRA MATERIALS

Extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

- 6.6.1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
- 6.6.2. Plastic Diffusers and Lenses: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
- 6.6.3. Battery and Charger Data: One for each emergency lighting unit.
- 6.6.4. Ballasts: 5 for every 100 of each type and rating installed. Furnish at least one of each type.
- 6.6.5. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.
- 6.6.6. Control Devices: 1 for every 10 of each type and rating installed. Furnish at least one of each type

SECTION – 7 POWER CABLES

7.1. SCOPE

This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and above.

7.2. SUBMITTALS

- A.** Product Data - General: For each type of product indicated.
- B.** Qualification Data: For testing agency.
- C.** Field quality-control test reports.

7.3. MATERIALS

A. L.T. CABLES.

The low tension cables shall be manufactured to the requirements of B.S 2004 , B.S. 6004, and rated at 250/400 and 600/1000 Volts as the case may be.

- 1 The conductors shall be annealed copper conductors, single or strand circular or shaped as the case may be , to B.S.S. 6360/69.
- 2 The conductors specified for use in the cables shall be of at least 98% IASC conductivity.
- 3 The reference temperature for the purpose of determining the standard resistance of the conductors shall be 20 degree centigrade.
- 4 The conductors shall be insulated with poly-vinyl chloride insulation. The minimum thickness of the insulation shall be in conformity with the specifications to which it is manufactured.
- 5 Power cables shall be multicore cables, insulated and sheathed, armoured or unarmoured as required.
- 6 Various conductors forming the cables shall be laid together and voids shall be filled with soft plastic or fibers materials so as to give a circular shape to the cable.
- 7 A tough PVC shall be extruded over the cable so as to cover the insulated conductors and fillers.

- 8 Where armouring is required, a soft PVC jacket shall be provided over the laid up cable. Steel wire armouring shall be applied on a tough PVC sheathed extruded over the cable so as to cover the insulated conductors, fillers, jacket and armouring.
- 9 Complete identification of the cable together with Owner's identification markings if required shall be embossed on the final over sheath of the cable at every meter length.

B. CABLES TERMINATIONS.

All PVC power cables shall be terminated with suitable brass cable glands for securing the armour wires and incorporating a packing ring for excursion of water and moisture. The cables shall be secured at required spacing by means of cleats fixed to walls or roofs or hangers and where multiple runs occur perforated metal tray made of heavy gauge galvanized steel shall be used.

C. CABLE MARKERS.

For underground installation cable position markers shall be sited in the ground where cables change direction and at 30 meter intervals along straight runs of the cables. Markers shall also be provided to locate the position of joints. Cable markers shall be made of cast iron. Any one of the following words shall be embossed / engraved for the identification of cable routes.

11000 V. Cable.

440 V. Cable.

The markers shall comprise of a cast iron circular disc of 115 mm dia. and 10 mm thick to which an angle iron 25x3 mm bar 710 mm long shall be riveted at one end. The end of the bar shall be fork-opened upto a length of 75mm. this end shall be embedded in a cement concrete block of ratio 1:3:6 to a length, of 180mm. The concrete block shall have a shape of truncated pyramid with base 152x152 mm and a vertical height of 200 mm. The cable marker shall be buried in the ground such that its total height above ground level is 267 mm.

D. CABLE JOINTS.

The CONTRACTOR shall be in possession of cable jointing kit and all termination shall be made by a bonafide and experienced cable jointer. All cable termination boxes kits and glands shall be of recognized makes and complete with claw clamps, ferrules, lugs, tapes, solders and jointing compounds.

E. WIRES & CORDS.

The wires & cords for conduit wiring shall be single core, made of stranded copper conductors, PVC insulated, tested to B.S. 6004, 1975. The voltage grade shall be 300/500 volts or 450/750 V unless otherwise specified on drawings and Schedule of values.

In order of preference as approved by the Engineer. The size of the wire shall be as follows:

- i) for light or fan point wiring with 1.5MM square (or 3./029) or as specified in the SCHEDULE OF VALUES.
- ii) for light circuit wiring with 2.5MM square (or 7/0.29) or as specified in the SCHEDULE OF VALUES.
- iii) for power plug 15A wiring with 4 MM square (or 7/.036) or as specified in the SCHEDULE OF VALUES.
- iv) the sizes of cables from Main Panel Board to Sub-Main Panel board to distribution baords shall be as shown on drawings or as specified in SCHEDULE OF VALUES.

7.4. DELIVERY, STORAGE AND HANDLING

The cables shall be delivered wound over strong drums of suitable dimensions. The cables ends shall be fastened to the drums and completely protected in suitable manner to protect any injury to the cables during transportation and handling. The direction of rolling shall be clearly marked with bold arrows on both faces of the drums.

7.5. EXECUTION

1. The CONTRACTOR shall be under obligations to provide all labor, material and accessories for the installation of cables shown on drawings and listed in the SCHEDULE OF VALUES conforming to the specifications in this section.
2. The CONTRACTOR shall provide, without any extra cost, all material for termination of cables such as lugs, solders, clamps, supports, ferrules, bushes, fluxes, taps, fixing pins, identification tags, , earthing clips, straps for a complete terminal jointing operation in accordance with the best modern practice.
3. For underground cable installation the depth of digging the trench shall be such that the top surface of the cable shall not be less than 900mm and more than 1100 mm from the finished ground level. It will be CONTRACTORs responsibility to obtain true trench levels.
4. Cable routes indicated on the drawings shall be followed unless otherwise specified or agreed to by the Engineer. Where change in direction of the cable is

necessitated, the bending radius of the cable shall not be less than the diameter of the cable drum or 12 times the diameter of the cable whichever is greater.

5. At all road crossing the cables shall pass through 100/150mm dia. core thickness minimum 1-1/2" RCC pipes with A class specifications sleeve shrouded in cast concrete, the mouths of which shall be sealed with cable bitumen compound of approved quality after drawing the cable. The road cuts shall be first filled with mud and 50mm size ballast upto 182mm level below the road surface and after ramming it properly 1500mm thick layer of cement concrete 1:3:6 shall be laid over it.
6. The cushion of sand to be provided in the trench before laying the cable shall not be less than 75mm and after laying the cable 150mm. The total depth of cushion of sand shall be not less than 225mm. Over the final layer of sand, tiles/bricks or concrete masonry blocks of adequate strength 2" thick and 300mx200mm in size shall be provided to the satisfaction of the Engineer. The rest of the trench shall be backfilled with earth, in 150mm layers and rammed properly before dressing.
7. All trenches and holes dug for laying the cables shall not be left open and unprotected for any length of time without completing the job and backfilling it to the satisfaction of Engineer. Where trenches are left open due to some unavoidable reasons the CONTRACTOR shall exhibit suitable danger signals such as banners, red flags and red lamps etc.
8. All cables shall always be lead out or lead into the ground through 2.5 meter long G.I. pipes of 75mm dia. or suitable size with 40% clearance as approved by the Engineer. The length of the pipe in the ground shall be 600mm. The pipe should be attached to the poles with approved clamps.
9. Markers of approved design and inscription shall be installed as specified.
10. For installation of cable in perforated metal trays, the cable shall be tied or bunched properly in an approved manner. Similarly for installation of cables on cleats or raceway approval of the Engineer shall be obtained.
11. The CONTRACTOR shall furnish all material and labor to pull in and install wires and cables as required. The CONTRACTOR shall also supply, without extra cost, wire accessories e.g. plugs, solder, clamps, supports, bushes, fixing pins, adhesive tapes, connectors, identification tags, straps, filling compound and earthing clips etc. as are required to be furnished for complete wiring installation in accordance with standard practice. The pulling of wires shall be taken in hand only when all conduit system is complete. All termination shall be mechanically strain free and electrically sound.
12. The wiring of the installation shall be strictly in accordance with the scheme,

13. All wiring shall be continuous between terminations and use of connectors or joints disallowed. Spur and Tee connections are strictly prohibited. Looping in system shall be followed throughout.
14. Manufacturers recommended lubricant shall be allowed to facilitate pulling of wires, use of all other kind of oil and soap is prohibited.
15. All wires occupying the same conduit shall be pulled together. Wires and cords at the time of pulling shall not be subjected to a bending radius more than 10 times the overall diameter of cables. Cable manufacturer's recommendation of pulling speed and pulling tension on cables shall govern the pulling operation.
16. Not more than 2 circuit wires shall be bunched in the same conduit. Wires of two different phases, however, shall not be run or terminated in the same outlet box for single phase wiring of lights, switches and sockets.
17. Porcelain or moulded plastic connectors shall be provided for a joint between light point wiring and light fixture wiring and housed in the outlet box provided for this purpose. The contactor after terminations are made shall be wrapped in PVC insulation tape.
18. The quantity and the size of the wire contained in any one conduit shall not be in excess of the numbers permitted by I.E.E regulations.

19. All point and circuits wiring shall be solidly earthed by 14SWG (2.5mm square) PVC insulated wire of color Green, Yellow to serve as CPC which shall be run inside the conduit.
20. All 5A & 15A socket shall be wired separately direct from D.B. without any claim of circuit and distinctly from light point wiring, or as specified in SCHEDULE OF VALUES. However 5 Amps socket shall be controlled by D.B, or as specified in SCHEDULE OF VALUES.

7.6. QUALITY ASSURANCE

The cables should be tested according to BS 6004. The following tests shall be carried out at least

- i) Dielectric Strength Test.
- ii) Instantaneous and long time break down strength test.
- iii) Temperature rise test.
- iv) High voltage test.

Test certificates covering all these tests shall accompany the cables supplied by the Sub-contractor. After carrying out the tests as laid down in these specifications both ends of the cables shall be sealed at the manufacturer's works.

The owner may require the Engineer to witness the tests as specified herein and the CONTRACTOR shall make necessary arrangements for the presence of the Engineer on such tests and obtain their signatures in testimony thereof without any cost to the Owner.

SECTION – 9 MAIN L.T SWITCH BOARD

9.1 SCOPE

This Section includes metal-enclosed, low-voltage, power circuit-breaker switchgear rated 1000 V and less for use in AC systems.

The L.T. switchboard shall be indoor type, free standing, free supporting , floor mounted, totally enclosed, sheet steel clad, dust and vermin proof, completely wired, factory assembled and suitable for installation back to the wall and capable of front attendance. The switchboard shall comprise of multipanel suitable for housing, air circuit breakers, moulded case breakers or load break switches as shown on the drawings and as listed in the schedule of quantities. The switch board shall be designed to suit services conditions and ensure security and safety during operation, inspection, operation, cleaning and maintenance. The switch board shall be designed and tested to IEC recommendations. Each panel shall withstand strain of 2000 Volts insulation level for one minute power frequency test. The switchboard shall comprise of the following main components and each removable component of the same rating shall be physically and electrically interchangeable. Switchboard to British Electrically Standard 41-5 are also acceptable.

9.2 SUBMITTALS

- A. Product Data: For each type of switchgear, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each type of switchgear and related equipment.
 - 1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Include the following:
 - a. Tabulation of installed devices with features and ratings.
 - b. Enclosure types and details.
 - c. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
 - d. Bus configuration with size and number of conductors in each bus run, including phase, neutral, and ground conductors of main and branch buses.
 - e. Current rating of buses.

- f. Short-time and short-circuit current rating of switchgear assembly.
- g. Nameplate legends.
- h. Mimic-bus diagram.
- i. Utility company's metering provisions with indication of approval by utility company.
- j. Features, characteristics, ratings, and factory settings of individual over current protective devices and auxiliary components.

Wiring Diagrams: Power, signal, and control wiring.

- a. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where pipe and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- b. Samples: Representative portion of mimic bus with specified finish. Manufacturer's color charts showing colors available for mimic bus.
- c. Field quality-control test reports.
- d. Updated mimic-bus diagram reflecting field changes after final switchgear load connections have been made, for record.
- e. Operation and Maintenance Data: For switchgear and components to include in emergency, operation, and maintenance manuals
 - i. Manufacturer's written instructions for testing and adjusting over current protective devices.
 - ii. Time-current curves, including selectable ranges for each type of over current protective device.

9.3 MATERIALS**MOULDED CASE CIRCUIT BREAKERS**

The moulded case circuit breakers shall be triple pole and of the rating specified in the schedule of quantities and/or shown on drawings. The MCCB shall be of fixed type, having trip free, solenoid & manually operated mechanism and ON/OFF/Trip position

indicators. The MCCBS shall comprise of adjustable hydraulic magnetic releases for overload protection and instantaneous adjustable electro-magnetic releases for short circuit protection. The tripping devices shall have time current characteristics so that positive discrimination and selective tripping is obtained assuring the tripping under fault conditions of only the breaker in the circuit ahead of the fault location. The MCCB shall have a rupturing capacity of 35 KA (or as specified) and shall be manufactured and tested to IEC publication 157-1 Part I or BS 4752/1977 or BSS 3871 Parts I & II. The MCCBS manufactured by Merlin GERIN, Terasaki, ABB, Legerand are acceptable.

BUS BARS AND CONNECTIONS

A set of four bus bars, three for phases and one for neutral, made of copper having 98% IASC conductivity shall be provided. The bus bars in panels and chambers shall be tin plated, PVC insulated having minimum clearance of 50mm between phase to phase and 25mm between phase to earth. The neutral bar shall be of the same section. All the bus bars shall be mounted on insulators at suitable intervals and should be extensible on both ends. The marking and arrangement of bus bars, main connections and small wiring shall conform to BS 158/1961. Bus bars and bus bar connections shall conform to BS 159/1957.

ENCLOSURES

The enclosures shall be fabricated from 3mm thick high grade sheet steel and shall be designed to house all the live parts which shall be accessible through front doors. The enclosure shall be tropical in design completely dust and vermin proof and liquid repellent, with special regard to danger of flashover both in service and in isolated position. Hinged lockable doors shall be provided on the front and bolted plates at the rear. Adequate air circulation by means of vent covered with suitable metal gauze shall be provided in the enclosures. All exterior and interior surfaces of the enclosure shall be thoroughly cleaned and freed of dust, rust and greasy matter. The enclosures shall be

given three coats of paint. The primer shall be Zinc Chromate and/or iron oxide. The second and third coats shall be top quality battleship gray enamel. Enclosure for each panel shall be provided with designation labels as directed by the Engineer. The enclosures / enclosure door shall be double earthed with appropriate size of copper conductor.

EARTHING

The switchboard shall be effectively earthed by means of a copper strip of 25mmx3mm (1"x1/8") Cross-section bolted to connections near the bottom of the switchboard.

ACCESSORIES

Designation labels, lifting lugs, foundation bolts, interconnecting nuts bolts, and washers, thimbles, lugs, leveling shims cable glands and/or cable end boxes for all the

sizes of incoming and outgoing cable shall be supplied with the switchboard.

SUBMAIN PANEL BOARDS

The Sub-Main panel board shall be similar to the Main L.T. board and the components in its fabrication may differ and shall comprise of the components as shown on drawings and as described or listed in the Schedule of quantities. The rupturing capacity of the each component for sub-main boards shall be as under:-

- | | | | |
|----|-------------------------------|---|-------------------------|
| 1) | Air circuit breakers. | - | 35 KA (or as specified) |
| 2) | Moulded case circuit breaker. | - | 25 KA |

All the other details and specification as in section 9 shall be applicable to this section.

9.4 DELIVERY, STORAGE, AND HANDLING

- a. Deliver switchgear in sections of lengths that can be moved past obstructions in delivery path.
- b. Store switchgear indoors in clean dry space with uniform temperature to prevent condensation. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- c. If stored in areas subjected to weather, cover switchgear to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchgear; install electric heating (250 W per section) to prevent condensation.

9.5 EXECUTION

All labor, equipment, tools and plant required to complete the installation shall be provided by the CONTRACTOR. The switchboard shall be fixed firmly on the floor in perfect line, plumb and level position. All incoming and outgoing cable connections shall be made including earth connections.

3.1 EXAMINATION

- A. Examine elements and surfaces to receive switchgear for compliance with installation tolerances and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

9.6 PROJECT CONDITIONS

Installation Pathway: Remove and replace building components and structures to provide pathway for moving switchgear into place.

Existing Utilities: Do not interrupt utilities serving facilities occupied by Government or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

Notify Project Director/COR not less than seven days in advance of proposed utility interruptions. Identify extent and duration of utility interruptions.

Indicate method of providing temporary utilities.

Do not proceed with utility interruptions without Project Director/COR's written permission.

9.7 QUALITY ASSURANCE

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Manufacturer's Field Service: Engage factory-authorized service representative to perform the following:

1. Inspect switchgear installation, including wiring, components, connections, and equipment.
 2. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 26 Sections.
 3. Complete installation and startup checks according to manufacturer's written instructions.
 4. Assist in field testing of equipment including pretesting and adjusting of equipment and components.
 5. Report results in writing.
- C. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- D. Perform the following field tests and inspections and prepare test reports:

TYPE TESTS.

- i) Temperature rise test.
- ii) Mechanical endurance test.
- iii) Making / breaking capacity test.

ROUTINE TEST

High Voltage tests.

VISUAL AND MECHANICAL

- c) Perform each visual and mechanical inspection and electrical test
1. Switchgear.
 2. Circuit breakers.
 3. Protective relays.
 4. Instrument transformers.

5. Metering and instrumentation.
 6. Ground-fault systems.
 7. Battery systems.
 8. Surge arresters.
 9. Capacitors.
- d) Remove and replace malfunctioning units and retest as specified above.

TRAVELLING, BOARDING/LODGING, FOOD OF THE TESTING AGENCY TO BE BORNE BY THE CONTRACTOR

ADJUSTING

Set field-adjustable, protective-relay trip characteristics

PROTECTION

Temporary Heating: Apply temporary heat to switchgear, according to manufacturer's written instructions, throughout periods when switchgear environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

SECTION – 10 DISTRIBUTION BOARDS

10.1 SCOPE

- A. This Section includes load centers and panel boards, over current protective devices, and associated auxiliary equipment rated 600 V and less for the following types:

1. Lighting and appliance branch-circuit panel boards.
2. Distribution panel boards.
3. Transient voltage surge suppressor panel boards.

The distribution boards shall be either free standing, cubical type or wall mounting type suitable for surface and/or recessed mounting. Each distribution boards (D.B.) shall be tropical in design, fully dust and vermin proof and liquid repellent. The cabinet housing the main components shall be fabricated from mild steel sheets 16 SWG thick and reinforced with structural steel members welded to it. Front access, mechanically locked and hinged doors, fully gasketed, having one or two leafs depending upon the size of the cabinet shall be provided on each cabinet. All openable parts shall be provided with gaskets or lining and screwed to the main body with chromium plated screws. The cabinets after fabrication shall be thoroughly cleaned completely derusted and degreased before applying one coat of zinc or lead based primer and then two coats of top quality synthetic emulsion or stove enamel paint in battleship gray colour. All exposed parts of the D.B's shall be covered with 5mm thick bakelite sheet. A load distribution chart shall be provided in each D.B showing the areas fed by each circuit and a suitably sized pocket inside the front door shall be provided for the purpose. Each D.B. shall be delivered complete with all instruments accessories, rating plates, designations, as approved by the Engineer.

Suitable cable entry glands shall be provided as required for floor mounted boards on the incoming cables but for outgoing cables and/or wall mounted boards exact number of conduit entry holes as are required shall be provided with male brass bushes. The bushes shall be tin plated and fully shrouded or housed in gasketed compartments.

10.2 SUBMITTALS

- A. Product Data - General: For each type of panel board, over current protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features,

performance, electrical characteristics, ratings, and finishes.

- B. Shop Drawings For each panel board and related equipment.
 - 1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Enclosure types and details
 - b. Bus configuration, current, and voltage ratings.
 - c. Short-circuit current rating of panel boards and over current protective devices.
 - d. Features, characteristics, ratings, and factory settings of individual over current protective devices and auxiliary components.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Qualification Data: For testing agency.
- D. Field quality-control test reports including the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Panel board Schedules: For installation in panel boards. Submit final versions after load balancing.
- F. Operation and Maintenance Data: For panel boards and components to include in emergency, operation, and maintenance manuals. Include:
 - 1. Manufacturer's written instructions for testing and adjusting over current protective devices.
 - 2. Time-current curves, including selectable ranges for each type of over current protective device.

10.3 MATERIALS

COMPONENTS.

The main components e.g. earth leakage circuit breakers (ELCB / RCCB), moulded case circuit breakers, **load break switches**, HRC fuses and instrument as shown on the drawings and as described in schedule of quantities shall be the same as described in section 9. However miniature circuit breakers (MCBs) used in D.B's are briefly described hereunder:

MCBs

The incoming shall have triple pole mcb's suitable for use on 415V 50Hz, AC and the outgoing mcbs shall be single pole or single phase for use on 220V, 50Hz, AC. The ratings are as shown in drawings and/or described in the schedule of quantities.

The mcbs shall be moulded case type having hydraulic magnetic short circuit releases, contacts, operating mechanism and arcing chambers.

The mcbs shall be manufactured and tested to BSS 3871/1966, and shall have a rupturing capacity of 7.5 KA or as specification SCHEDULE OF VALUES. The final circuit mcb's on the outgoing, shall however be rated 5KA.

FABRICATION AND FEATURES

- A. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
- B. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
- C. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
- D. Directory Card: With transparent protective cover, mounted inside metal frame, inside panel board door.
- E. Bus: Hard-drawn copper, 98 percent conductivity.
- F. Bus Bars of Power Distribution and Branch Circuit Panel boards: Provide hard drawn copper. The neutral bus shall be isolated from both the ground bus and the cabinet, except at the service entrance or at the output of separately derived systems and shall be grounded in accordance with the NEC.

- G. Main and Neutral Lugs: Compression or mechanical type suitable for use with conductor material.
- H. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
- J. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.
- K. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box.
- L. Split Bus: Vertical buses divided into individual vertical sections.
- M. Skirt for Surface-Mounted Panel boards: Same gage and finish as panel board front with flanges for attachment to panel board, wall, and ceiling or floor.
- N. Feed-through Lugs: Compression or mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
- O. Provide 10 percent spare circuit breakers, 20 percent spaces for future breakers, and 20 percent overall spare current carrying capacity for future expansion.

10.4 EXECUTION

All labour, equipment, tools, plant and accessories required to complete the installation shall be provided by the CONTRACTOR. The distribution board shall be fixed as required in perfect line and plumb. All earth terminations shall be made on the neutral block.

TESTING.

All D.B's shall be tested at manufacturer's works and tests shall be witnessed by the Engineer without incurring any additional expense to the Owner.

SECTION – 11 TELEPHONE

11.1 SCOPE

The work under this section consists of supplying, installing, testing and commissioning of all material and services for provision of Structured Cabling as specified herein, as shown on Tender Drawings and stated in the Schedule of values.

The CONTRACTOR shall discuss the Structured Cabling Layout with the Engineer and co-ordinate at site with other services for exact route, location and position of the system.

To ensure optimum performance, components of the structured cabling shall be sourced from the one manufacturer. This shall eliminate potential problems such as electrical and mechanical mismatch between different manufacturers.

Structured Cabling shall be covered under the manufacturers Certified Installation Program and installed by Certified Installation Company. Under this arrangement, the supply of components from the one manufacturer will facilitate the manufacturers Certification requirements of sole supply.

The Structured Cabling shall support the following systems, but not be limited to these systems.

11.2 MATERIALS

Data Communications

EIA-232-D, RS-422, RS-423, ISDN, Ethernet (10 Base-T, 100 Base-T and 1000 Base-T & 10 Giga), 100 Base VG Any LAN, Token Ring, Fibre Distributed Data Interface (FDDI), Twisted Pair-Physical Medium Dependant (TP-PMD) and ATM (155 Mbs and 622 Mbs), etc.

APPLICABLE STANDARDS AND CODES

The following standards and all “normative addendums” shall be applicable to this document and must be adhered to for any installation work performed.

EIA/TIA 568-A Commercial Building Telecommunications Cabling Standard.

EIA/TIA 569-A Commercial Building Telecommunications Cabling Standard Pathways and Spaces.

TSB 67 Transmission Performance Specifications for Field-Testing of Unshielded Twisted-

Pair Cabling Systems.

IEEE 802.3 Wire Speed Performances

IEEE 802.1Q VLAN

All copper/optical fibre cabling, components and connecting hardware shall be in accordance with latest revision of ISO/IEC 11801, ISO/IEC/TR3 8802-1, ISO/IEC/8802-3, ISO/IEC 61935-1, IEC 60364-1, IEC 60950, EN50173, EN50174-1, EN50174-2, and EIA/TIA TSB 72/73.

MATERIALS

A. Category – 6 Cable (Telephone Network)

The horizontal cabling shall be Category – 6 U/UTP or S/FTP, 4 pair cable with 1.0 Gigabit support and specified up to 250MHz. The cable employed shall have excellent electrical characteristics and shall possess low weight, have slim design and shall be non corrosive (to IEC 60754-2), low smoke (to IEC61034), and flame retardant (to IEC 60332-3) and DIN VDE 0472, Part 804, test type C). The cable shall meet the requirements for EN 55022 Class B emission and EN 55024 immunity to be compliant with standards of electromagnetic compatibility and shall comply with following specifications:

Compliance

IEEE 802.af, IEEE 802.3at for PoE applications ANSI/TIA-568-C.2:2009 Category 6ISO/IEC-11801, 2nd Edition Class EIEC 61156-5:2002 Category 6LSZH: IEC 60332-1, IEC 60754, IEC 61034

Electrical Specification

- DC Resistance - 72 Ohms / Km
- DC Resistance Unbalance - 2% Max
- Insulation Resistance - 5000M-KM/Min
- Wiring Sequence - TIA/EIA 568 A+B

- Delay Skew - 25 ns/100 meter Max

Mechanical Specification

- Diameter of Copper - AWG 24
- Wire Insulation - PVC/PVC
- Deployment Area - Dry and Damp Rooms
- Temperature Range (moving) - 0 °C to +50 °C
- Operating Temperature - -20 °C to +60 °C
- Min. Bend Radius for Single Flexure - ≥ 40 mm
- Min. Bend Radius during Installation ≥ 60 mm

B. Category – 6 Outlets (Telephone Network)

The horizontal cabling shall be terminated on Un-shielded or Shielded Cat-6 RJ-45 keystone Jacks support 250 Mhz as per SCHEDULE OF VALUES on white plastic wall plate with shutter. The category-6 outlets shall have provision of two outlets and shall accommodate one or two inserts (as per SCHEDULE OF VALUES). To maintain security, the module shall not be removable from the front of wall plate. The Cat-6 RJ-45 outlets shall be protected by a spring-loaded shutter which will cover the outlet when not in use. Outlets shall comply with following specifications:

Compliance

IEEE 802.af, IEEE 802.3at for PoE applications.

ANSI/TIA/EIA 568AB.2.2001, ISO/IEC11801:2002

EN50173-2 Category 6 standards

Electrical Specification

- DC Resistance - < 200 milli Ohms
- DC Resistance Imbalance - < 50 milli Ohms
- Insulation Resistance - > 500 Mega Ohms min
- Wiring Sequence - TIA/EIA 568 A+B
- Delay Skew - < 1.25 nanoseconds

Mechanical Specification**Jack Contact**

- Material of RJ45 pins - Copper alloy
- Plating of RJ45 pins - Gold plate 1.4 μ m
- Operating Life (number of RJ45 Insertions) - 1500
- Plastic Housing (material type) - Polycarbonate (VO)

IDC Block

- Material of metal terminals - Copper alloy
- Wire Accommodation (diameter range) - AWG 22-24
- Tool Accommodation (required or not) - NO
- Gas Tight IDC Cable Termination (yes/no) YES
- Plastic Housing (material type) - Polycarbonate (VO)
- Operating Life (number of re-terminations) up to 5

C. Patch Cord: (Telephone Network)

The U/UTP or S/FTP Cat-6 patch cords should be designed for 1.0 Giga applications up to 250 MHz and provides transmission performance meeting Category 6 specifications. Cables should be low skew products. I.e. the difference in propagation delay between the individual pairs is very low. Additional features are the slim design and low weight of the cables. The cable should meet or exceed the requirements for EN 55022 Class B emission and EN 55024 immunity allowing for networks to be built that are compliant with the standards on electromagnetic compatibility.

Compliance

IEEE 802.af and IEEE 802.3at for PoE applications

ANSI/TIA-568-C.2 and ISO/IEC-11801 (2nd Edition), IEC 61156-2,

EN 50173; EN 50288-6-2 Category 6 standard

D. Patch Panel: (Telephone Network)

Industry Standard 19" UTP / STP Patch panel capable of accommodating 24 No. Category – 6 U/UTP or S/FTP outlets. The patch panel should be modular having 1U height with integral strain relief. Front panel of patch panel should be made of high-grade steel.

Compliance

IEEE 802.3an, IEEE 802.3af (PoE), IEEE 802.3at (PoE+)

ISO/ IEC 11281:2002

IEC 60603-7, TIA-968-A (formerly FCC Part 68 Subpart F)

11.3 EXECUTION

All cable installations shall be completed according to the local regulatory board and conform to EIA/TIA 568-A and shall comply with the following criteria.

A. UTP Cable Installation

Cables shall be installed in already laid steel cable trunking (within suspended ceilings) suitably anchored to the building structure, and in conduit in floor and partitions (concealed). Cables shall be secured every 600mm using hook and loop

fastening ties. Due care shall be taken to not over tighten ties and place undue strain on the cabling infrastructure.

Cables shall be bundled to a maximum of 24 UTP cables and each bundle individually supported within the cable trunking.

Bend radius shall be limited to 10 times the cable diameter (UTP)

During the installation of a UTP cable (maximum 90 metres) the pull distance should not exceed 30 metres at any one time.

Internal Multi-pair Telephone cables should be in accordance with BT type CW 1308. These cables are used for connecting telephone systems and data exchange systems with a plain annealed copper conductor of 0.4mm, 0.5mm, 0.6mm & 0.9mm diameter with PVC insulation. These are twisted to form a pair and over sheathed in white, cream, gray & black PVC. A rip cord is laid under the sheath to facilitate its removal. An optional 1.38mm diameter earth copper wire is available on 50 pair cables and above.

Conductor:	Class 1 Solid annealed Bare Copper Conductors to BS 6360:1991/IEC 60228:2005 (note - IEC 60228:2005 replaces BS 6360:1991)
Insulation:	PVC (Polyvinyl Chloride)
Twisted Pair:	Two single wires are twisted to form a Pair
Separator:	Polyester Tape longitudinal wrapped
Rip Cord:	Nylon
Earth Wire:	PVC insulated Bare Copper
Outer Jacket:	1) PVC 2) LSZH (Optional)
Jacket Colour:	Cream

11.4 TESTING AND COMMISSIONING

The following tests shall be carried out and the results shall be documented and maintained to form part of the "AS BUILT" drawings.

1. Test all of the UTP copper cable installation for termination and twisted pair integrity, including continuity, polarity, pin-assignment and color codes
2. Perform visual inspections to ensure that each pair of wires remains twisted as close as possible to the termination point, to maintain the impedance and minimize attenuation losses.
3. Test that the UTP cable pairs comply with the Specification using measuring device for Near End Cross-talk and Signal Attenuation complying with EIA/TIA 568-A.

The documentation required at the completion of the installation phases shall contain all of the following information, together with any other information the installer has acquired during the installation.

1. “As-Built” documentation, showing total cabling and connection installed, utilizing floor space plans and cable record sheets. This documentation shall show all cables and outlets incorporating the full numbering and marking convention supplied.
2. All test results and certification information, identified by cable, connection and numbering convention, necessary for all copper cables.

All components of the Structured Cabling should be sourced from one manufacturer to ensure minimal impedance mismatch and best possible NEXT performance and to guarantee the Category-6 performance from end to end.

The Structured Cabling System should operate without introducing or being affected by electromagnetic radiation from other sources. Maintaining segregation from other services or screening is to be ensured to achieve acceptable immunity.

SECTION – 12 DATA

12.1. SCOPE OF WORK

The work under this section consists of supplying, installing, testing and commissioning of all material and services for provision of Structured Cabling as specified herein, as shown on Tender Drawings and stated in the Schedule of values.

The CONTRACTOR shall discuss the Structured Cabling Layout with the Engineer and co-ordinate at site with other services for exact route, location and position of the system.

The Structured Cabling work with accessories shall also comply with the General Specifications.

A. GENERAL

To ensure optimum performance, components of the structured cabling shall be sourced from the one manufacturer. This shall eliminate potential problems such as electrical and mechanical mismatch between different manufacturers.

Structured Cabling shall be covered under the manufacturers Certified Installation Program and installed by Certified Installation Company. Under this arrangement, the supply of components from the one manufacturer will facilitate the manufacturers Certification requirements of sole supply.

The Structured Cabling shall support the following systems, but not be limited to these systems.

Data Processing

Mainframe access, Client Server, Enterprise Server, Messaging Systems and Electronic Mail, common document utilization, Client Database, Voice and Video, etc.

Data Communications

EIA-232-D, RS-422, RS-423, ISDN, Ethernet (10 Base-T, 100 Base-T and 1000 Base-T & 10 Giga), 100 Base VG Any LAN, Token Ring, Fibre Distributed Data Interface (FDDI), Twisted Pair-Physical Medium Dependant (TP-PMD) and ATM (155 Mbs and 622 Mbs), etc.

B. APPLICABLE STANDARDS AND CODES

The following standards and all “normative addendums” shall be applicable to this document and must be adhered to for any installation work performed.

EIA/TIA 568-A Commercial Building Telecommunications Cabling Standard.

EIA/TIA 569-A Commercial Building Telecommunications Cabling Standard Pathways and Spaces.

TSB 67 Transmission Performance Specifications for Field-Testing of Unshielded Twisted-Pair Cabling Systems.

IEEE 802.3 Wire Speed Performances

IEEE 802.1Q VLAN

All copper/optical fibre cabling, components and connecting hardware shall be in accordance with latest revision of ISO/IEC 11801, ISO/IEC/TR3 8802-1, ISO/IEC/8802-3, ISO/IEC 61935-1, IEC 60364-1, IEC 60950, EN50173, EN50174-1, EN50174-2, and EIA/TIA TSB 72/73.

12.2 MATERIALS**A. Category – 6a Cable**

The horizontal cabling shall be Category – 6a U/UTP or S/FTP, 4 pair cable with 10 Gigabit support and specified up to 500MHz. The cable employed shall have excellent electrical characteristics and shall possess low weight, have slim design and shall be non corrosive (to IEC 60754-2), low smoke (to IEC61034), and flame retardant (to IEC 60332-3) and DIN VDE 0472, Part 804, test type C). The cable shall meet the requirements for EN 55022 Class B emission and EN 55024 immunity to be compliant with standards of electromagnetic compatibility and shall comply with following specifications:

Compliance

IEEE 802.3an :2006 (10GBASE-T)

ANSI/TIA-568-C.2:2009 Category 6A

ISO/IEC-11801, 2nd Edition Class EA

IEC 61156-5:2002 Category 6A

LSZH: IEC 60332-1, IEC 60754, IEC 61034

Electrical Specification

- DC Resistance - 72 Ohms / Km
- DC Resistance Unbalance - 2% Max
- Insulation Resistance - 5000M-KM/Min
- Wiring Sequence - TIA/EIA 568 A+B
- Delay Skew - 25 ns/100 meter Max

Mechanical Specification

- Diameter of Copper - AWG 23
- Zero Halogen foam - skin
- Wire Insulation - Material
- Sheath Material Retardant - Zero Halogen, Flame
- Deployment Area - Dry and Damp Rooms
- Temperature Range (moving) - 0 °C to +50 °C
- Operating Temperature - -20 °C to +60 °C
- Min. Bend Radius for Single Flexure - ≥ 40 mm
- Min. Bend Radius during Installation - ≥ 60 mm

B. Category – 6a Outlets

The horizontal cabling shall be terminated on Un-shielded or Shielded Cat-6a RJ-45 keystone Jacks as per SCHEDULE OF VALUES on white plastic wall plate. The category-6a outlets shall have provision of two outlets and shall accommodate one or two inserts (as per SCHEDULE OF VALUES). To maintain security, the

module shall not be removable from the front of wall plate. The Cat-6a RJ-45 outlets shall be protected by a spring-loaded shutter which will cover the outlet when not in use. Outlets shall comply with following specifications:

Compliance

IEEE P802.3an and TIA/EIA TSB155 (draft) Category 6A specifications and Class E channel requirements of 2nd edition.

IEC 60603-7-5, ISO/IEC 11801 and CENELEC EN50173-1, the Cat 6A channel requirements of TIA/EIA-568-B.2-10

Electrical Specification

- DC Resistance - < 200 milli Ohms
- DC Resistance Imbalance - < 50 milli Ohms
- Insulation Resistance - > 500 Mega Ohms min
- Wiring Sequence - TIA/EIA 568 A+B
- Delay Skew - < 1.25 nanoseconds

Mechanical Specification

Jack Contact

- Material of RJ45 pins - Copper alloy
- Plating of RJ45 pins - Gold plate 1.4 µm
- Operating Life (number of RJ45 Insertions) - 1500
- Plastic Housing (material type) - Polycarbonate (VO)

IDC Block

- Material of metal terminals - Copper alloy
- Wire Accommodation (diameter range) - AWG 22-24

- Tool Accommodation (required or not) - NO
- Gas Tight IDC Cable Termination (yes/no) YES
- Plastic Housing (material type) - Polycarbonate (VO)
- Operating Life (number of re-terminations) - up to 5

C. Patch Cord (Cat6a):

The U/UTP or S/FTP Cat-6a patch cords should be designed for 10 Giga applications up to 500 MHz and provides transmission performance meeting Category 6a specifications. Cables should be low skew products. I.e. the difference in propagation delay between the individual pairs is very low. Additional features are the slim design and low weight of the cables. The cable should meet or exceed the requirements for EN 55022 Class B emission and EN 55024 immunity allowing for networks to be built that are compliant with the standards on electromagnetic compatibility.

Compliance

IEEE 802.3af and IEEE 802.3at for PoE applications IEEE 802.3an-2006, and ISO 11801 Class EA channel standards IEC 60603-7, ISO/IEC-11801, ANSI/TIA-968-A, ANSI/TIA-568-C.2 Category 6A

D. Patch Panel:

Industry Standard 19" UTP / STP Patch panel capable of accommodating 24 No. Category – 6a U/UTP or S/FTP outlets. The patch panel should be modular having 1U height with integral strain relief. Front panel of patch panel should be made of high-grade steel.

Compliance

IEEE 802.3an, IEEE 802.3af (PoE), IEEE 802.3at (PoE+), ISO/ IEC 11281:2002

IEC 60603-7, TIA-968-A (formerly FCC Part 68 Subpart F)

E. Fiber Optic Cable (Om3)- IF APPLICABLE

Backbone cabling from the system equipment (Data Centre) to the telecommunication closet shall be connected with optical fiber cable in Star / Ring topology with failover optical fiber link to connecting floors or buildings.

Om3 Fiber optic cabling shall be armored multi-strand 50/125 or Single Mode 9/125 micron support 10 Giga applications as per SCHEDULE OF VALUES for core/cladding diameter multimode / single mode graded index fibers, tightly jacketed. The sheath shall be colored orange or some other bright color to help distinguish fiber media from other wiring. The cable construction should be metal free to avoid requirement of grounding, lightening protection etc.

Optical Fiber cables Om3 shall be constructed with a central tube filled with water blocking jelly giving it excellent water and moisture resistance. Two corrugated steel armoring and two steel wires strengthening with in the inner PE sheath and an outer PE sheath give this cable excellent tensile strength, mechanical and environmental protection. They have small diameter, light weight and installation friendly since they come in a single tube with loose tube fiber count up to 12 fibers. Their compact construction protects the loose tube from shrinking, the double armor makes it crush, rodent and impact resistance, the outer PE sheath gives it ultraviolet protection. This cable is suitable for outdoor distribution through ducts, conduits or aerial pipe lines. They come in larger delivery length, so can also be used in long distance communication system, service drop cables, building interconnections.

Specified Core multi-strand 50/125 micron multimode or single mode, tightly jacketed fiber optic indoor cable. Orange colored outer sheath. Metal free cable construction avoiding requirement of grounding, lightening protection having following physical and transmission characteristics:

Compliance

ITU-T G652.B OS1, ITU-T G652.D OS2, ITU-T G651.1 OM1, OM2, OM3, OM4. IEC60793-2-10 type A1a.1/A1b OM1/OM2 ISO/IEC 11801, ISO/IEC 24702, IEEE 802.3z Gigabit Ethernet ANSI/TIA/EIA 568C.3, RoHS Compliant Directive 2002/95/EC

No. of Fibers:	06, 08, 12, 24, 48, 96,
Core Diameter	50.0 \pm 3.0 μ m or 9.0 micron
Numerical Aperture	0.200 \pm 0.0015
Cladding Diameter	125.0 \pm 2.0 μ m
Core-Clad Concentricity	\leq 3.0 μ m
Cladding Non-Circularity	<2.0%

Core Non-Circularity	$\leq 5\%$
Coating Diameter	$245 \pm 5 \mu\text{m}$
Coating Cladding Concentricity:	< 12
Operating Wavelengths:	850 and 1300 nm
Bare Fiber Attenuation:	2.5 dB/km per 850 nm, 0.8 dB/km per 133 nm
Cable Fiber Attenuation:	3.5 dB/km per 850 nm 1.5 dB/km per 1300 nm

Fiber Type	Type. Attenuation in dB/km		Bandwidth-length product (OFL) in MHz x km	
Multimode Fibre	850 nm	1300 nm	850 nm	1300 nm
(50 μm)	2.5	0.8	≥ 500	≥ 800

F. Fiber Optic Patch Cord (Om3) IF APPLICABLE

Fiber-optic Om3 patch cords support 10 Giga Applications shall be provided for connections with active networking hardware. The cable shall be manufactured from single pair optical fiber. Each patch cord shall be terminated at switch end with SC/MT-RJ/LC connector plugs design to be pushed on and pulled off active device as applicable to facilitate administration. The patch panel end shall be terminated with duplex SC/LC connectors.

Compliance

TSE: EN 61587-1 Mechanical Structures For Electronic

Equipment - Tests for IEC 60917 and IEC 60297

Climatic and Environment: EN 61587-1/4.2, IEC60068-2-1,

IEC60068-2-2, IEC60068-2-30,

Earth Bond: EN61587-1/6.2

Flammability: EN61587-1/6.3

G. Racks

All racks, shall be modular (Imported) 19 inch racking products. In all cases the backbone cabling sub-system shall be terminated into rack mounted panels and presented as MTRJ fibre connectors. The rack shall have Plexi glass door with pivoted handle and square key. Earthing point, multi socket strip for supplying power to the active components of data network and roof ventilator shall be provided in each rack.

Cable management shall be provided with manageable patching facility. Horizontal management side rings shall provide an environment for ongoing maintenance of all future patching and enable move and changes to be handled easily.

The CONTRACTOR shall be responsible for all records and labeling of the rack mounted panels, both fibre and UTP, to the convention provided by the Client.

1. Wall Mounted Racks.

Wall Mounted Cabinets as per SCHEDULE OF VALUES (Size from 4U to 18U) structure is welded and painted with powder coated. Removable side panels ensure easy installation and maintenance. Easy cab available in different sizes. Comply with ANSI/EIA RS-310-D, DIN41497 part 1, IEC 297-2, DIN41497 part 7, GB/T3047, 2-92 standards.

2. Floor Standing Racks.

Floor Standing Racks as per SCHEDULE OF VALUES (Size 22U to 47U) shall be modular with vertical cable manager, 4 Way Fans, Front Glass Door, and Rear Perforated with two side opening for easy access. These racks shall accommodate networking accessories and suitable for communication rooms and data centers. Comply with ANSI/EIA RS-310-D, IEC 297-2, DIN 41491, PART 1, DIN 41497, PART 7, GB/T3047.2-92, ETSI standards.

I. Metal Cable Management

Metal Cable management facilities within each rack at the Wiring Closet Sub-system are a mandatory requirement.

The cable management channels shall be made up of power coated mild steel 19-inch rack mount panels with integrated “fingers” in which to route the patch leads. The horizontal channel formed by these fingers shall be enclosed by a snap-on ABS metal cover at both ends of panel separate ABS plastic rings shall be mounted using the rack mount bolts of the panel to create a vertical ring run up the rack. These rings shall be sufficiently large enough to comfortably accommodate in excess of 50 patch leads, yet narrow enough not to overhang the width of the rack or obscure the horizontal ring run segment.

The cable management panels should be mounted on the patching facility between active and passive rows of RJ45 ports. In this way, patch leads from every RJ 45 patch panels port are directed to the cable management panels above or below the outlet, so that at no time even when fully populated, outlets are obscured by patch leads. Such a layout shall ensure the patching facility, when cable management is properly utilized, does not go out of control and can be efficiently utilized for adds, moves and changes over the life of the Structured Cabling System.

The metal rings shall be sufficiently large enough to comfortably accommodate in excess of fifty (50) patch leads at any time.

In view of the dynamic nature of the patching facility, the “fingers” of the cable management panels shall be made of mild steel and integral to the metal panel, so that excessive force on the patch leads do not deform the channel formed within the “fingers”. The cable management panel shall be supplied with a snap on cover to discretely conceal the patch leads when the patching facility is static.

To facilitate effective patching during the life of the Structured Cabling System, the rack shall be laid out for minimal clutter and the shortest reasonable route for patch cords.

J. Core / Access Switch (HP - 2920 Series Switches)

Access switch should be rack mountable and shall serve the floor users and should have provision to connect to the core switch via fiber optic backbone. Access switch shall have following specifications:

24 x 10/100/1000 ports with 2 Nos. SFP Gigabit ports

2 Nos 1000 or 10 G-Base-T-LX-SX-SFP

48 10/100/1000 ports with 2 Nos. SFP Gigabit ports

2 Nos. 1000/10GBase-T-LX-SX SFP

Switching capacity:

24 Port Switch 85 Gbps;

48 Port Switch 148 Gbps

Forwarding rate:

24 Port Switch 6.6 Mpps

48 Port Switch 10.1 Mpps

Store-and-forward switching; latency <12 μ s

Layer 2 Switching

MAC Address 8K MAC addresses

VLANs (IEEE 802.1Q)

Link Aggregation IEEE 802.1ad (LACP), Gigabit ports only

Auto-negotiation

Auto-negotiation of port speed, duplex, and connection (MDI/MDIX)

Traffic control IEEE 802.1w full-duplex flow control

Support for Broadcast Storm Suppression (3,000 pps threshold)

STP/RSTP IEEE 802.1w Rapid Spanning Tree Protocol (RSTP)

Backward-compatible with STP

Fast-start mode

Spanning tree enable/disable per port

Layer 3 Switching

Hardware based routing

Multi-netting (multiple IP interfaces per VLAN)

RIP (Routing Information Protocol), v1 and v2

1. Split Horizon
2. MD5 authentication of the RIP packets
3. Password authenticated RIP packets
4. Host route advertisements

Multicast Filtering for 64 multicast groups

IGMP (Internal Group Management Protocol) snooping on Layer 2 interfaces

IGMP 1 and v2

IGMP Querier

Network protocol DHCP (Dynamic Host Configuration Protocol) Helper/Relay

UDP Helper

ARP, ARP Proxy

Convergence

Priority Queues for hardware queues per port

Weighted Round Robin queuing

Traffic Prioritization Priority based on:

1. DSCP (Diff Serv Code Point)
2. IEEE 802.1p Class of Service (CoS) VLAN priority
3. TCP/UDP destination port number
4. Default port priority
5. Auto classification of 3Com NBXR telephony traffic

Bandwidth Management Port-based bandwidth management:

1. 1 Mbps increments (10/100 ports)
2. 8 Mbps increments (Gigabit ports)

Security

Network Login IEEE 8.2.1X user authentication

Access Control Lists Port-based ACLs

Switch Protocol Security MD5 cipher-text and clear-text authentication for RIP v2 packets

Switch Management Local or RADIUS management of switch passwords

Trusted IP Management Addresses

Telnet

Management

Remote Management SNMP v1

Telnet

Web-based

SNMP

Mirror port/RAP (Roving Analysis Port) One-to-one

RMON (Remote Monitoring) four groups: statistics, history, alarm and events

K. Core / Access Switch (HP 1910 / 1920 Series Switches)

Access switch should be rack mountable and shall serve the floor users and should have provision to connect to the core switch via fiber optic backbone. Access switch shall have following specifications:

24 x 10/100/1000 ports with 2 Nos. SFP Gigabit ports

2 Nos 1000 or 10 G-Base-T –LX-SX-SFP

48 10/100/1000 ports with 2 Nos. SFP Gigabit ports

2 Nos. 1000/10GBase-T-LX-SX SFP

Switching capacity:

24 Port Switch 45 Gbps;

Forwarding rate:

24 Port Switch 6.6 Mpps

Layer 2 Switching

MAC Address 8K MAC addresses

VLANs (IEEE 802.1Q)

Link Aggregation IEEE 802.1ad (LACP), Gigabit ports only

Auto-negotiation

Auto-negotiation of port speed, duplex, and connection (MDI/MDIX)

Traffic control IEEE 802.1w full-duplex flow control

Support for Broadcast Storm Suppression (3,000 pps threshold)

STP/RSTP IEEE 802.1w Rapid Spanning Tree Protocol (RSTP)

Backward-compatible with STP

Fast-start mode

Spanning tree enable/disable per port

12.3 EXECUTION

All cable installations shall be completed according to the local regulatory board and conform to EIA/TIA 568-A and shall comply with the following criteria:

A. UTP Cable Installation

Cables shall be installed in already laid steel cable trunking (within suspended ceilings) suitably anchored to the building structure, and in conduit in floor and partitions (concealed). Cables shall be secured every 600mm using hook and loop

fastening ties. Due care shall be taken to not over tighten ties and place undue strain on the cabling infrastructure.

Cables shall be bundled to a maximum of 24 UTP cables and each bundle individually supported within the cable trunking.

Bend radius shall be limited to 10 times the cable diameter (UTP)

During the installation of a UTP cable (maximum 90 metres) the pull distance should not exceed 30 meters at any one time.

12.4 TESTING AND COMMISSIONING

The following tests shall be carried out and the results shall be documented and maintained to form part of the "AS BUILT" drawings.

1. Test all of the UTP copper cable installation for termination and twisted pair integrity, including continuity, polarity, pin-assignment and color codes
2. Perform visual inspections to ensure that each pair of wires remains twisted as close as possible to the termination point, to maintain the impedance and minimize attenuation losses.
3. Test that the UTP cable pairs comply with the Specification using measuring device for Near End Cross-talk and Signal Attenuation complying with EIA/TIA 568-A.
4. Test each termination Optical Fibre in both directions, recording all results of the calibrated optical power. Make sure in all cases that measurements are within those provided in the specification.

The documentation required at the completion of the installation phases shall contain all of the following information, together with any other information the installer has acquired during the installation.

1. "As-Built" documentation, showing total cabling and connection installed, utilizing floor space plans and cable record sheets. This documentation shall

show all cables and outlets incorporating the full numbering and marking convention supplied.

2. All test results and certification information, identified by cable, connection and numbering convention, necessary for all Optical Fibre and copper cables.

All components of the Structured Cabling should be sourced from one manufacturer to ensure minimal impedance mismatch and best possible NEXT performance and to guarantee the Category-6a performance from end to end.

The Structured Cabling System should operate without introducing or being affected by electromagnetic radiation from other sources. Maintaining segregation from other services or screening are to be ensured to achieve acceptable immunity.

SECTION – 13 FIRE ALARM

13.1 SCOPE

Furnish a complete 24V DC analogue addressable, electrically supervised, zone annunciated, fire detection and alarm system as specified herein and indicated on the drawings. The system shall include but not be limited to, a control panel or panels with integral power supply to provide the 24V DC, signal initiating devices, audible and visual alarm devices, and all accessories required to provide a complete and operating system.

The fire alarm system shall be wired as 2 core signal loops. 24V DC power wiring shall be installed to alarm sounders via addressable sounder modules or via conventional monitored sounder outputs within the control panel.

Loop powered sounders shall be connected directly to the signal loops..

13.2 MATERIALS

Codes and Standards

The following codes and standards shall apply to work of this section.

EN54-2 and EN54-4	-	Fire Alarm CIE and PSE
ISO9001	-	Quality control
BS 5839:part 1	-	Fire Detection and Alarm Systems for Buildings

Qualifications of Manufacturers

Manufacturers of the products supplied for the fire alarm system shall have been in the business of manufacturing Fire Alarm products for at least five years. They shall confirm compliance to the above codes and standards.

Fire Alarm Control Panel (FACP)

A. Functional Description

The fire alarm control panel (FACP) shall be the central processing unit of the system, receiving and analyzing signals from fire sensors, providing audible and visual information to the user, initiating automatic alarm response sequences and providing the means by which the user interacts with the system.

The FACP shall be certified as meeting the requirements of EN54-2 and EN54-4

by a suitable, notified body. A certificate and test report shall be made available for inspection as evidence of certification.

The FACP shall be easily configurable to meet the exact detection zone and output mapping requirements of the building.

The FACP shall be microprocessor based and operate under a multitasking software program. Operating programs and configuration data shall be contained in re-configurable non-volatile memory. Retention of the memory shall not rely on any form of battery or capacitor back-up device. The FACP shall incorporate separate processors for loop processing and central processing.

Provision shall be made for each addressable loop to be sub-divided into geographical zones. The section of wiring corresponding to each zone circuit shall be protected from faults in other sections by line isolator modules.

In order to facilitate re-configuration and system extension, the allocation of addresses to devices shall be independent of their physical arrangement on the loops.

Up to 240 individually addressed standard devices shall be configured on each addressable loop. Loop powered sounders and beacons incorporated as sensor bases shall be available.

The FACP shall have the capability to support sub-addressing of addressable modules.

It shall be possible to fit a 40-column printer to the FACP which will print system events automatically and logged data upon request.

The FACP shall incorporate a real time clock to enable events to be referenced against time and date.

B. Additional Components

It shall be possible to fit the FACP with a network board to allow up to sixty-four control panels to communicate with each other. The network shall be fully fault tolerant and shall continue to function normally under any single fault condition.

It shall be possible to fit the FACP with a modem board to allow remote interrogation and monitoring of a network of control panels.

It shall be possible to fit up to thirty-two, sixteen way input/output modules, eight way relay modules, six way sounder modules or four way conventional

zone modules or any combination thereof to each control panel. Modules shall connect to a separate serial bus but shall be programmable in the same manner as devices connected to the addressable loops.

C. Configuration

It shall be possible to perform configuration updates on site using a portable personal computer and a Windows[®] based configuration utility. This facility shall allow the following parameters to be set: -

D. System

- a) Produce a configuration file which contains data for up to 64 control panels connected together as a network.
- b) Set cause and effect tables for any device to operate devices or functions on any panel or panels connected to the network.
- c) Upload and view graphically the configuration from a single panel or entire network of panels.

E. Control panel

- a) Panel name (network identity, fifteen characters minimum)
- b) Panel text (comfort message or service company forty characters minimum)
- c) Change code numbers for access levels two and three.
- d) Select sounder ringing mode as common, zonal or two stage
- e) Select first and second stage delay times for each sounder output to between zero and five minutes.
- f) Set number of loops on panel as one, two or four
- g) Set number of zones on panel as 0,16, 48 or 96
- h) Set loop sounder volume globally
- i) Set start and end times for day night mode for each day of the week

F. Detectors

- a) Allocate a zone
- b) Set a delay before the panel responds to a fire signal
- c) Indicate pre-alarm
- d) Set day sensitivity and night sensitivity separately
- e) Address loop powered base sounders
- f) Allocate a forty character location text message

G. Call points

- a) Allocate a zone
- b) Allocate a forty character location text message

H. Switch units (input)

- a) Allocate a zone for each input and the device itself
- b) Define input action as fire, fault, pre-alarm, technical alarm, evacuate, alert, security alarm, silence alarm, reset, transparent, disablement or test mode.
- c) Change the input action message from the default to any one of the above or to any one of a user defined library of 10 additional action messages.
- d) Set a delay before the panel responds to a fire signal
- e) Select whether the input requires the control panel to be reset or is self clearing upon removal of the input
- f) Allocate a forty character location text message

I. Relay or sounder units (output)

- a) Allocate a zone for each input and the device itself
- b) Define whether the device responds to evacuate inputs, as a sounder (default ringing), is silenceable, needs to be reset or produces a single pulsed operation of between one and five seconds (programmable)

- c) Has a delay before operating (zero to five minutes)
- d) Allocate a forty character location text message
- J. Loop powered sounders and beacons
 - a) Allocate a zone
 - b) Define whether the device responds to evacuate inputs, as a sounder (default ringing), is silenceable or needs to be reset.
 - c) Has a delay before operating (zero to five minutes)
 - d) Allocate a forty character location text message
- K. Panel Construction

The housing containing the FACP shall be of metal construction and shall be capable of being surface or semi-flush mounted. It shall be complete with cable knock-outs in sufficient quantity to accommodate all likely cabling requirements.

The housing shall afford a minimum ingress protection to IP30 and it shall not be possible to open the FACP without the use of a special tool or key.

L. Panel Indications

The FACP shall monitor the status of all devices on the addressable loops for fire, short-circuit fault, open-circuit fault, incorrect addressing, unauthorized device removal or exchange, pre-alarm condition and contaminated detector condition.

The FACP shall also monitor the status of internal connections and interfaces including charger and batteries.

The FACP shall provide the following discrete visual indications:

- | | | |
|----|------------|----------------------|
| a) | POWER ON | green LED indicator |
| b) | FIRE ALARM | red LED indicator |
| c) | PRE-ALARM | yellow LED indicator |
| d) | ON TEST | yellow LED indicator |

- e) BUZZER SILENCED yellow LED indicator
- f) DELAY ACTIVE yellow LED indicator
- g) MORE EVENTS yellow LED indicator
- h) GENERAL DISABLEMENT yellow LED indicator
- i) GENERAL FAULT yellow LED indicator
- j) POWER FAULT yellow LED indicator
- k) SYSTEM FAULT yellow LED indicator
- l) SOUNDER FAULT/DISABLED yellow LED indicator

M. Display

In addition to the indications above, the FACP shall have an integral 240 x 64-pixel graphic LCD display.

The display shall incorporate a backlight which will illuminate upon any event (excluding mains failure) or button press.

The display shall be capable of simultaneously indicating the number of outstanding events and their types as well as the current event.

N. Panel Controls

The panel shall be provided with at least the following manual controls: -

- a) SILENCE BUZZER
- b) ACKNOWLEDGE ALARM
- c) RE-SOUND ALARM
- d) RESET
- e) LAMP TEST
- f) FUNCTION 1
- g) MORE FIRES

- h) MORE EVENTS
- i) HELP
- j) MENU NAVIGATION PAD (UP,DOWN,LEFT,RIGHT,ENTER,EXIT)

O. Remote Monitoring Signals

The FACP shall contain at least three programmable inputs to allow interconnection to other systems.

The FACP shall contain at least two programmable outputs to allow interconnection to other systems.

The FACP shall be capable of monitoring and controlling remote site devices, such as relays for the control of plant and dampers directly from the addressable loops.

The FACP shall be capable of monitoring fire doors such that, in the event of a fire alarm condition, an event is generated to warn of the failure of a fire door to close.

P. Software

The FACP shall have, as a standard software enhancement, the ability to annunciate a pre-alarm condition designed to give the earliest possible warning of potential fire condition without raising the full alarm condition.

The FACP shall have as a standard software enhancement the ability to automatically adjust the alarm threshold levels to compensate for changes in detector sensitivity due to contamination over a period of time.

The FACP shall have, as a standard software enhancement, the ability to provide an indication that a detector is nearing a level of contamination, which requires that it be replaced or serviced.

The FACP shall have, as a standard software enhancement, the ability to provide automatic warning that a detector has reached a level of contamination, which requires that it be replaced or serviced.

The FACP shall have, as a standard software enhancement, the ability to synchronize loop data transmission to eliminate the possibility of data corruption due to cross-talk or similar effects.

The FACP shall have, as a standard software enhancement, extensive, context sensitive help screens to offer additional information on system status at all times.

FAS. 1 Sounders

The FACP shall provide the necessary outputs to separately operate a minimum of two monitored circuits of common system sounders. Each output shall be capable of driving a sounder load of up to 1A.

The FACP shall also be able to monitor the integrity of and control standard sounder circuits, via a suitable addressable module.

The FACP shall be capable of providing a two-stage alarm sounder facility that can be programmed, either on a zonal basis or common system basis, to meet the requirements of the fire authority. Sounder outputs shall be available as follows:

- Alert, intermittent pulsed tone
- Evacuate, continuous tone

The FACP shall have the facility to change, on a per sounder zone basis, the sound output dependent upon whether the source of alarm is:

- an automatic detector, e.g. smoke, heat,
- a manual call point.

The FACP shall have the facility to generate a slow pulsed output to all sounder circuits in response to a security alert input.

FAS. 2 Fault Reporting

The FACP shall monitor all critical system components and interconnections, internal and external, such that a failure, which would prevent the correct operation of the alarm functions, causes the FAULT indicator to light and a message to be given on the alphanumeric display within 60 seconds of occurrence.

The following faults shall be reported in the manner described above: -

- a. Loop Short Circuit

- b. Loop Open Circuit
- c. Un-configured Device
- d. Device missing
- e. Addressable Device Failure
- f. Incorrectly Configured Device
- g. System fault (processor)
- h. Low battery
- i. Charger failure
- j. Earth fault monitoring
- k. Battery Fault
- l. Mains Failure
- m. Sounder Wiring Open Circuit (per circuit)
- n. Sounder Wiring Short Circuit (per circuit)

To help fault finding and repair, the FACP shall provide text messages to indicate the location of where a fault has occurred in the system.

FAS. 3 System Management

The FACP shall incorporate the following system management facilities:

- a. Isolate/re-connect individual outputs or inputs of addressable points
- b. Isolate/re-connect individual zones
- c. Isolate/re-connect individual loops
- d. Isolate/re-connect all or individual sounder circuits
- e. Isolate/re-connect all volt-free contacts individually
- f. Isolate/re-connect panel inputs

- g. Walk-test of a selected zone to verify detectors and sounders
- h. View system status
- i. Print event log
- j. Print point status.
- k. Set time
- l. View contamination status

Access to the facilities describe above shall be restricted to user Engineer level or above.

The FACP shall have an event log capable of storing the last 500 events that have occurred. It shall be possible to view the content of the log via the alphanumeric display. Events shall be displayed in chronological order with the newest events first. It shall be possible to scroll through the events.

The FACP shall be designed so that, for each type of analogue addressable detector, the overall response time including the sensor, the signal transmission system and the fire decision algorithm, meets the requirement of European Standards.

The FACP shall be capable of isolating a group of selected detectors in areas of the building where maintenance work is carried out.

FAS. 4 Automatic Fire Detectors (General)

A. General

The manufacturer shall have available the following types of analogue addressable automatic sensors, for direct connection to the system addressable loops:

- Ionisation smoke sensors
- Photoelectric smoke sensors
- Heat sensors
- Multi-sensors

B. Addressable Units

The manufacturer shall be capable of offering two-state addressable versions of the following units, taking only one address from the loop:

- Ionisation smoke detectors
- Photoelectric smoke detectors
- Heat detectors
- Photoelectric beam smoke detectors
- Ultra-violet flame detectors
- Conventional detector interface module
- Addressable sounder modules
- Addressable relay interface modules
- Addressable switch monitoring modules
- Short circuit isolator modules (no address required)
- Loop powered sounders
- Manual call points for indoor use
- Manual call points for outdoor use
- Multiple inputs/outputs
- Radio interfaces to detectors and call points

C. Conventional Units

The manufacturer shall have available the following types of conventional automatic detectors, manual call points and ancillary units for connection to the system via suitable interfaces:

- Ionisation smoke detectors
- Photoelectric smoke detectors

- Photoelectric beam smoke detectors
- Ultra-violet flame detectors
- Heat detectors
- Manual call points for indoor use
- Manual call points for outdoor use
- Remote indicator units
- Sounders

Analogue Addressable and addressable detectors and modules must be able to transmit to the FACP an address to be used in the system configuration.

It must be possible to connect and mix automatic detectors, addressable manual call points and addressable modules within the same zone sub-division of an addressable loop.

All equipment connected to the system addressable loop, either directly or via interfaces, shall be proofed against electrical noise, high frequency pulses and electromagnetic influences from other equipment.

The manufacturer shall have available suitable equipment to test and remove or exchange all three main types of automatic point-type detectors when installed.

D. Ionization Smoke Detectors

The Ionization smoke detectors shall be capable of detecting visible and invisible combustion gases emanating from fires, using a dual Ionization chamber in which the air is ionized by a single radioactive source.

The radioactive source used shall be AM 241 of one microcurie or less.

The Ionization smoke detectors shall be designed to have high resistance to contamination and corrosion and shall include RFI screening to minimize the effect of radiated and conducted electrical interference.

The Ionization smoke detectors shall be suitable for operation in air speeds of up to 10m/s and shall incorporate screens to minimize the effects of small insects.

The manufacturer shall have available the following versions of the Ionization

smoke detector to meet different applications:

- Analogue addressable
- Conventional

The Ionization smoke detector shall incorporate LED's, clearly visible from the outside, to provide indication of alarm actuation.

In locations where the detector is not readily visible, remote indicator units shall be provided.

E. Photoelectric Smoke Detectors

The photoelectric smoke detectors shall be capable of detecting visible combustion gases emanating from fires and shall employ the forward light-scatter principle.

The point-type photoelectric smoke detectors shall be equally sensitive to a wide range of combustible materials.

The design of the point-type photoelectric smoke detector sensing chamber shall be optimized to minimize the effect of dust deposit over a period of time. The chamber cover shall be removable for ease of cleaning or replacement.

The point-type photoelectric smoke detectors shall incorporate screens designed to prevent all but the very smallest of insects from entering the sensing chamber, (50 holes per square centimeter or more).

The photoelectric smoke detectors shall be designed to have high resistance to contamination and corrosion and shall include RFI screening to minimize the effect of radiated and conducted electrical interference.

The manufacturer shall have available the following versions of the point type photoelectric smoke detector to meet different applications:

- Analogue addressable
- Conventional - normal sensitivity
- Conventional – normal sensitivity – delayed response
- Conventional – normal sensitivity – Intrinsically Safe

The photoelectric smoke detector shall incorporate two LED's, clearly visible from the outside, to provide indication of alarm actuation.

In locations where the detector is not readily visible, remote indicator units shall be provided.

F. Multi-Sensors – Analogue Addressable

The multi-sensor should be capable of monitoring two different sensing elements:

- 1) Photoelectric
- 2) Thermal

The design of the point-type multi-sensor photoelectric smoke detector sensing chamber shall be optimized to minimize the effect of dust deposit over a period of time. The chamber cover shall be removable for ease of cleaning or replacement.

The point-type multi-sensors shall incorporate screens designed to prevent all but the very smallest of insects from entering the sensing chamber, (50 holes per square centimeter or more).

The multi-sensors shall be designed to have high resistance to contamination and corrosion and shall include RFI screening to minimize the effect of radiated and conducted electrical interference.

The sensor should be able to operate in the following modes:

G. Combination Mode

The sensor should be able to operate as a photoelectric sensor but when the ambient temperature reaches 40° C or above, the thermal elements should be capable of sensing the 'Rate of Rise' and adjust the sensitivity of the photoelectric element automatically. The sensitivity of the photoelectric should be increased via an internal algorithm.

H. Photoelectric mode

The sensor should be able to return the analogue value for the photoelectric element during a normal polling sequence.

The sensor should also be able to signal to the FACP if the thermal sensing

element exceeds a fixed temperature threshold.

I. Thermal mode

The sensor should be able to return the analogue value for the thermal element during a normal polling sequence. The sensor should also be able to signal to the FACP if the photoelectric sensing element exceeds a pre-defined threshold.

The multi-sensor shall incorporate LED's, clearly visible from the outside, to provide indication of alarm actuation. The LED's should be controlled from the FACP if the LED's flash during the normal polling sequence.

The modes of the multi-sensor should be controlled by the FACP, when the FACP changes from one mode to another the FACP should re-calibrate the multi-sensor.

In locations where the detector is not readily visible, remote indicator units shall be provided.

The multi-sensor should have the capability of monitoring both sensing elements, if either or both of the elements fail it should be reported and displayed at the FACP.

J. Duct smoke detectors

The manufacturer shall produce standard equipment for the installation of smoke detectors in air ducts. This equipment shall be designed to accommodate the manufacturer's standard smoke detectors and bases: Analogue addressable, Addressable and conventional.

K. Heat detectors

The heat detectors shall be capable of detecting rapid rise in temperature and/or fixed absolute temperatures.

The heat detectors shall employ two heat-sensing elements with different thermal characteristics to provide a rate of rise dependent response.

The heat detectors shall include RFI screening to minimize the effect of radiated and conducted electrical interference.

The manufacturer shall have available the following versions of heat detectors to meet different applications:

- Analogue addressable – grade 1, 2 or 3.
- Two state addressable – grade 1
- Two state addressable – grade 2
- Conventional – grade 1
- Conventional – grade 2
- Conventional – range 1
- Conventional – static 60 C
- Conventional – static 90 C

The heat detectors shall incorporate LED's, clearly visible from the outside, to provide an indication of alarm actuation.

In locations where the detector is not readily visible, remote indicator units shall be provided.

L. Detector Base

The automatic point-type fire detectors shall be fixed to the installation by mean of plug-in bases. Analogue addressable bases, sounder bases and conventional detector bases shall be available.

The three types of bases specified above shall incorporate the optional feature of being able to lock the detectors in place once plugged in. Termination facilities shall be available for earthing.

Standard conventional and Analogue Addressable bases shall not contain any electronic circuitry. This shall enable insulation and continuity checks to be completed on the wiring with the detector heads removed.

FAS 5 Other devices

A. Addressable Manual Call points

The addressable manual call points shall monitor and signal to the FACP the status of a switch operated by a "break glass" assembly. They shall be red in colour and suitable for surface or flush mounting. The addressable call points shall be provided with an integral red LED to indicate activation.

One version of the addressable call point shall be available mounted in a weatherproof housing, affording protection to IP 66.

The addressable call points shall be capable of operating by means of thumb pressure and not require a hammer. They shall be capable of being tested using a special 'key' without the need for shattering the glass.

The addressable call points shall incorporate a mechanism to interrupt the normal addressable loop scan to provide an alarm response within 3 seconds and shall be field programmable to trigger either an alert or an evacuate response from the FACP.

B. Addressable Sounder Module

The addressable sounder module shall be capable of monitoring and controlling two independent circuits of alarm sounders using a single loop address.

24 V DC power to drive the sounders shall be derived independently from the FACP.

The addressable sounder module shall be capable of operating both sets of sounders in a pulsing or continuous mode as determined on the module. Each circuit shall be individually programmable. Sounder circuits shall be capable of synchronization.

The addressable sounder module shall provide the facility to monitor the wiring to the sounders for open or short-circuit and transmit the necessary fault signal to the FACP. Each sounder circuit shall be separately fused.

The addressable sounder module shall provide the facility to monitor for failure of the power supply for the sounders and transmit the necessary fault signal to FACP.

The addressable sounder module shall provide a green LED indication when the FACP is polling it.

C. Conventional detector interface module

The conventional detector interface module shall be capable of monitoring two independent zones, each of up to 30 conventional detectors using a single loop address.

24 V DC power to power the conventional detectors shall be derived independently from the FACP.

The conventional detector interface module shall provide the facility to monitor the detector zones for open or short-circuit and transmit the necessary fault signal to the FACP.

The conventional detector interface module shall provide a remote LED facility to indicate detectors in alarm and shall provide a red LED indication when the FACP is polling it.

D. Addressable relay interface module

The addressable relay interface module shall be capable of switching two independent relays; either normally open or normally closed, each rated at 30V, 1Amp.

A single input shall provide open and short circuit monitoring facilities, set locally at the unit.

The addressable relay interface module shall use a single loop address.

The unit shall be powered directly from the addressable loop.

The addressable relay interface module shall provide an LED indication when the FACP is polling it.

E. Addressable switch monitoring module

The addressable switch monitoring module shall be capable of monitoring two independent voltage free contacts, each either normally open or normally closed, using a single loop address.

The unit shall be powered directly from the addressable loop.

The addressable switch-monitoring module shall provide a red LED indication when the FACP is polling it. The LED shall be continuously lit when either input is active.

F. Short Circuit Isolator Module

The short circuit isolator module shall provide protection on the addressable loop by automatically disconnecting the section of wiring between two modules where a short circuit has occurred.

The short circuit isolator module shall derive power directly from the addressable loop and shall provide an LED indication that the module has

tripped. A base mounted version is available.

G. Loop powered sounders

Addressable electronic sounders shall be connected directly to the detection loops where required. These shall be incorporated in a suitable mounting base so that an analogue smoke or heat sensor may also be connected to the base, if required. Loop powered sounders shall be ceiling or wall mountable. A cover plate shall be fitted when a sensor is not to be fitted on the sounder.

H. Photoelectric beam smoke detectors

The photoelectric beam smoke detectors shall be capable of detecting visible combustion gases emanating from fires and shall utilize the light obscuration principle. The emitter shall project a near infra red beam to the receiver.

Two types are acceptable:

1. The photoelectric beam smoke detectors shall consist of an emitter and a receiver pair. The detectors shall operate over a 5 – 100 metre range.
2. A Photoelectric reflective beam smoke detector consisting of a combined control unit and a separate reflector. The detector shall operate over a 5-30 metre range.

The photoelectric beam smoke detectors shall have automatic recalibration in order to adjust for contamination.

The photoelectric beam smoke detectors shall be designed to have high resistance to corrosion and shall include RFI screening to minimize the effect of radiated and conducted electrical interference.

The photoelectric beam smoke detectors shall incorporate two LED's, clearly visible from the outside and below, to provide indication of alarm actuation and fault.

I. Ultra-violet flame detectors

The flame detector shall be of a point-type. It shall be mounted on its base using a simple twist action for ease of installation and removal.

The flame detector shall be able to detect weak ultra-violet rays in a 120 cone of vision, in a direct line of sight.

J. Remote Indicator Unit

The remote indicator unit shall provide a remote indication for any detector that may be located in an enclosed or locked compartment.

The remote indicator unit shall be driven directly from its associated local detector. It shall be either flush or surface mountable.

FAS.6 Sounders

Two types of Electronic sounders shall be acceptable: loop-powered addressable sounders (see above) and stand-alone versions. Stand-alone versions shall be powered by 24 Volts DC from the FACP.

Non loop-powered versions shall be flush or surface mountable, red in colour. They shall have a minimum sound output of 95 dB (A) at 1 meter distance and shall have a maximum current consumption at 24V DC of 100 mA.

FAS. 7 Alarm Bells

Fire alarm bells shall be under dome type with a high resonance pressed alloy-steel gong to ensure a loud clear-tone ring. They shall be fully suppressed and polarized.

The operating mechanism shall be fully enclosed and the gong shall be red stove enameled for long life.

Alarm bells shall have a minimum sound output of 95 dB (A) at 1 metre distance, and shall have a maximum current consumption at 24V DC of 30 mA.

SECTION – 16 EARTHING

16.1 SCOPE

The CONTRACTOR shall be under obligation to supply all material and labor for the completion of the Earthing system as shown on drawings, listed in the schedule / Schedule of values and conforming to specifications laid down, hereinafter. The completed installation shall, in general, conform to British Code of Practice CP 1013/1965 and regulations of Pakistan Electricity Act. In the case of any conflict, specifications laid down hereinafter shall be followed. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

16.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features
 - 1. Test wells.
 - 2. Ground rods.
 - 3. Ground rings.
 - 4. Grounding arrangements and connections for separately derived systems.
 - 5. Grounding for sensitive electronic equipment.
- C. Qualification Data: For testing agency and testing agency's field supervisor.
- D. Field quality-control test reports.

16.3 MATERIALS

CIRCUIT PROTECTIVE CONDUCTOR.

The Circuit Protective Conductors and earthing leads shall be solid hard drawn, insulated electrolytic copper wires of sizes given on the drawings and Schedule of values. All fixing accessories such as saddles, copper bolts, nuts, and washers shall be provided. The size of conductor above 19/.083 shall be of 1-1/8" flat copper strip or as specified.

EARTH POINT.

It shall comprised of 1" dia & 10 ft long steel rod with 1mm copper conductor sleeve of 99.97% imported copper as earth electrode 100ft below ground level including cost of boring and lowering the rod 100ft down, complete with clamp and appropriate size of stranded copper conductor from rod to ground surface in 1½" dia G.I. pipe (length 20' only) with tee on top having watering cap, earth access hole comprising of 8" dia, 12" deep 16-SWG M.S. cylinder with 12-SWG M.S. cover, both hot dipped galvanized, as per detail shown in drawings.

EARTH CONNECTING POINT.

The earth connecting point in switch room or sub-station shall comprise 300mmx50mmx5mm (1'x2"x1/4") electrolytic copper bar having as many terminals of 3/8" dia. copper bolts, nuts, and washers as are required. The earth bar shall be fixed on bus bar insulators of appropriate size. The fixing bolts shall be galvanized and provided for fixing the bar on the wall. The bar shall be tinned for protection against corrosion. Copper tapes from various equipment and earth point shall be terminated on this bar.

EARTH ELECTRODE.

For the earthing of poles or any devices or equipment rates less than 15 KW, earth assembly as shown on the drawing shall be installed.

MANHOLE.

Cast concrete inspection manhole covers shall be provided on each earth point, as shown on drawings.

16.4 EXECUTION

- a. The circuit protective conductor (CPC) shall be run, inside, all along the conduit installation. The CPC shall be insulated as specified elsewhere.
- b. The C.P.C. or copper strip shall be laid all along the length of perforated metal tray or walls of masonry ducts, fixed at 3' intervals. At terminations the CPC or traps shall be bolted firmly to the equipment as per standard practice. Copper tape at straight through joints shall be brazed or cad welded. Joints between standard CPC shall be avoided or cad welded.

16.5 QUALITY CONTROL

- A. Testing: Engage a qualified testing agency to perform the following field quality-

control testing:

- B. Testing: Perform the following field quality-control testing:
 - 1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
 - 2. Test completed grounding system at each building electric service entrance, electric/telecom rooms, generator system, buildings and lightning protection system where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Tests at each ground rod before any conductors are connected are not required if a clamp-on ground tester is used. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - 3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results. Maximum value of acceptable system ground resistance is 1 ohms.
 - 4. Excessive Ground Resistance: If resistance to ground exceeds specified values, drive additional ground rods until resistance meets specified values.

SECTION – 17 LIGHTENING PROTECTION SYSTEM

17.1 SCOPE

This Section includes lightning protection for all buildings on the site. The Sub-contractor shall be under obligation to supply all labour and material for the completion of this installation to specification laid hereinafter, as shown on drawings and listed in the Schedule of values. The installation shall in general conform to British Standard 6651.

17.2 SUBMITTALS

- A. Product Data: For air terminals and mounting accessories.
- B. Shop Drawings: Detail lightning protection system, including air-terminal locations, conductor routing and connections, and bonding and grounding provisions. Include indications for use of raceway, data on how concealment requirements will be met
- C. Field inspection reports indicating compliance with specified requirements.

17.3 MATERIALS

- a. The Lightning Protection System shall comprise of lightning capturing devices fixed individually of a GI mast having arrangements for connection of conductor for diverting lightning current to ground system.
- b. The lightning streamer shall be based on the principal of collection volume and shall comprise of elements to avoid corona charge from affecting its performance adversely. All mounting accessories for fixing the pipe to the roof including guy wires, base for pipe, etc. shall be provided.
- c. There shall be at least two down conductors of soft drawn copper conductors which shall follow the most direct path between air terminal and the earth point through the down conductor.
- d. Care must be given to ensure that when the conductor is fixed there shall be no sharp bend and absolutely no upturns. Joints should be made with square clamps. These joints must be kept to minimum number. Test clamps should be provided for each down conductor near ground level. No joint in conductor should be made below the test clamp, except at the earth terminal. The earth resistance for the entire lightning protection system, in no case, should exceed ten ohm.

- e. When a metallic water pipe buried in the ground is available it should be bonded to the earth in compliance with the regulations of the Institute of Electrical Engineers. Group of electrodes, if used, should be capable of isolation for test purposes. Pipes carrying inflammable liquids or gas should not be used as a conductor or earth terminal. Earth rods should be at least 10 feet long and distance between the driven rods should be equal to their driven depth. Earth conductor should be buried 18" deep and in straight lines of radial formation.
- f. All reinforcement steel of columns and slabs, where possible, shall be connected with the protective system. Metal pipes and other metal building components of structure, within 6 feet of down conductor should be bonded at the top and bottom, and also at intermediate position if directed at site.
- g. The lightning arrestor should be mounted at the highest level and as close to the centers marked as possible. The Conductor shall be fixed to the roof with copper saddles by wood screws and nylon plugs.
- h. All the instructions and safety measure should be adhered to at site. The Project Manager should be consulted at site if any changes due to site conditions are required to be made.

17.4 EXECUTION

- A. Install lightning protection components and systems according to NFPA 780. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops.
- B. Conductors Concealment:
 - 1. Conceal the following conductor:
 - a. System conductors.
 - b. Down conductors.
 - c. Interior conductors.
 - d. Conductors within normal view from exterior locations at grade within 60 m of building.
 - 2. Do not embed conductors in concrete surrounding PCC as indicated on drawing details.

3. Notify Project Director/COR at least 48 hours in advance of inspection before concealing lightning protection components.
- C. Cable Connections: Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components, except those above single-ply membrane roofing.
- D. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 18-m intervals.
- E. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- F. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

SECTION – 18 PUBLIC ADDRESS MUSIC PAGING**18.1 SCOPE**

The extent of works shown on the drawing does not indicate the exact position of conduits and pipes. The CONTRACTOR shall ensure exact location and route of conduit and pipes in coordination with other services drawings, as per site requirements and as directed by the Engineer.

The conduit system shall be co-ordinate with manufacture's recommended accessories.

The quality and material for the accessories of conduits and pipes such as sockets, end cap, elbows, bushings, bends inspection/pull boxes, round boxes, etc., necessary for the complete installation shall be similar to that of conduits or pipes. All the accessories shall be supplied by the CONTRACTOR without any extra cost and deemed to have been included in the price of conduits/pipes.

The Work under this section consist of supplying, Supplying, installing and commissioning of all material and services of the complete Conduits and Pipe as specified herein and/or shown on Tender Drawings and stated in the Schedule of values.

The CONTRACTOR shall discuss the Public Address System layout with the Engineer and co-ordinate at Site with other services of exact route, location and position of the conduits and pipes.

The conduits and pipes with accessories shall also comply with the General Specifications for Electrical Works, Section-8001 and with other relevant provisions of the Tender Document

The public address system shall be used for paging within the building or specified area. The system shall include the entire component and installing methods/materials required ensuring full compliance to the code of the practice and applicable part of BS standard.

18.2 MATERIALS

All equipment supplied shall confirm as a minimum to the following protection classes.

Ip-40

Ip-54

Ip-65

18.2.1. SYSTEM OPERATION

The suggested system shall be operated through a central Control System. The system based on its amplifier, which will drive and handle all the speakers, fitted in the building.

The characteristic of some of the equipment in brief is given below; however sub-contractor / supplier shall provide the catalogue of each item for future details.

18.2.2. DETAIL OF EQUIPMENT

- a. Voice Alarm Controller
- b. Voice Alarm Router
- c. Booster Amplifier
- d. Ceiling Speaker
- e. WALL Speaker
- f. Column Speaker
- g. Power Amplifier
- h. Back Ground Music Unit
- i. Call Station

A. VOICE ALARM CONTROLLER:-

Voice Alarm Controller should have following features:-

- 1. Compliant with standards for emergency sound systems (IEC60849).
- 2. 6 – Zone System Controller.
- 3. Built-in 240 W Booster Amplifier.
- 4. 12 Business and emergency control inputs and outputs.
- 5. Line output for monitor or recording.

The Controller should have two BGM source inputs and a mic/line input with configurable priority, speech filter, phantom power and selectable VOX activation. A total of 16 priority levels can be specified for microphone, call stations and trigger inputs for optimum system flexibility.

The powerful 240W output section should have six transformer isolated 100V constant voltage outputs for driving 100V loud speakers in six separate zones. All zones may be individually selected from the front panel, and the BGM output level in each zone can be individually set in 6 steps. The BGM output is connected to the 70 V line, so it is possible to connect a total load of 480 Watts in a two-channel system combined with a 480 Watts

The output of the Booster should also be available as a separate output of 100 V and 70 V.

A separate 100 V call only output should be provided for addressing areas where BGM is not required but where priority announcements are. Six configurable volume override output contacts should be available for overriding local volume controls during priority calls. A LED VU – meter should monitor the output up to 255 messages can be stored in the internal 16 MB flash ROM, without a need for battery backup

Technical Specifications

Electrical

Mains Voltage	230 / 115 VAC, $\pm 10\%$, 50 / 60 Hz
Main Power Consumption	60 VA
Max/Rated output Power	360 W / 240 W
Battery Current	24 VDC, +20% / -10%
Max Mains Inrush Current	8A @ 230 VAC / 16A @ 115 VAC

Power Consumption

Mains Current	
System Idle	0.26 A = 60 VA
System Idle with Pilot Tone	0.6 A = 136 VA
Maximum Load ^{8*)}	3.6 A = 380 VA

24 V Current

System Idle 0.9 A

Maximum Load* 14 A

PerformanceFrequency Response 60 Hz – 18 kHz (+1/-3 dB,
@ - 10 dB ref. rated output)

Distortion <1% @ rated output, 1 kHz

Bass Control -8/+8 dB @ 100 Hz

Treble Control -8/+8 dB @ 10 Hz

Inputs**Mic / Line**

Input Type XLR, 6.3 mm jack

Sensitivity 1 mV / 1V

S/N 63 dB (flat at max volume)

S/N 75 dB (flat at min volume/muted)

Headroom 25 dB

Speech Filter -3 dB @ 315 Hz, high-pass, 6 dB/oct

Phantom Power Supply 12 V

VOX Trigger Level -20 dB (100 μ V mic / 100 mV line)
or via input contact

Limiter Automatic

Electrical**BGM and PC Call Station**

Input Type	Cinch stereo (converted to mono)
Input level	200mV – 2 V
Impedance	22 k Ohm
S/N	70 dB (flat at max volume)
S/N	75 dB (flat at min volume/muted)
Headroom	25 dB

Trigger Inputs

	6 EMG, 6 business
Type	MC1,5/14-ST-3,5
Activation	Programmable
Supervision	on EMG inputs, Programmable
Supervision method	Series / Parallel resistor
100 V input	MSTB 2,5 /16-ST
Power Handling Capacity	480 Watts

Approvals and Compliance**Certifications and Approvals**

EMC emission	acc. to EN 55103-1
EVAC compliance	acc. to IEC 60849
EMC immunity	acc. to EN 55103-2
Safety	acc. to EN 60065

B. VOICE ALARM ROUTER:-

Voice Alarm Controller should have following features:-

1. 6 EMG in put contacts
2. 6 Business input contacts
3. 6 Volume Override output contacts
4. Supervision within the Voice Alarm System (compliant to IEC60849)

The Voice Alarm Router should be an expansion unit adding 6 zones as well as 12 inputs- and 8 output contacts to the Voice Alarm System.

It must be able to use the built-in booster of the Voice alarm Controller, it should also provides output and inputs for one or two boosters in a multi amplifier one-or two-channel system. It should provide dual channel operation for calls and BGM simultaneously to a maximum of six different zones.

Technical Specification**Electrical**

Main Voltage	230 VAC / 115 VAC, ± 15%, 50 / 60 Hz
Max Mains Power	50 VAC
Consumption	
Battery Voltage	20-26.5 V
Max Battery Current	1.8 A
Max Mains Inrush Current	1.5 A @ 230 CAC / 3A @ 115 VAC

Power Consumption**Mains Current**

System Idle	0.2 A
Maximum Load	0.3 A

24 V Current

System Idle	0.51 A
Maximum Load 24 V Output	1.5 A
Trigger Inputs	6 EMG, 6 business
Type	MC1, 5/12-ST-3, 5
Activation	Programmable
Supervision	On EMG inputs, programmable
Supervision Method	Series / parallel resistor
100 V Inputs	MSTB 2,5 /16-ST
Booster 1	100 V / 70 V/0V
Booster 2	100 V / 0 V
Power Handling Capacity	1000 Watts

Outputs

100 V/70 V Output	MSTB 2,5 / 16-ST, floating
100 V Outputs	1000 W rated per zone
Volume Override Type	3 wire, 4 wire (24 V), 4 wire failsafe

Output Contacts

All Contacts	
Connector Type	MC1,5/12-ST-3,5
Rating	250 V 7A voltage free
General Purpose Relays (2x)	NO / COM

Environmental

Operating Temperature	+5 ⁰ C to +55 ⁰ C
Storage Temperature	-25 ⁰ C to + 55 ⁰ C
Relative Humidity	<95%
Dimensions	88x430 x 260 mm

Booster Amplifier

Booster / power amplifier should have following features:

Performance

Frequency Response	50 Hz – 20 kHz (+1/-3 dB, @ - 10 dB ref. rated output) <1%@rated output power, 1 kHz
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Inputs

Line input (3-pin XLR, 6.3mm phone jack, balanced)

Sensitivity	1 V
Impedance	20 kOhm
CMRR	>25 dB (50 Hz – 20 kHz)

Line Input 1,2 (3-pin XLR, balanced)

LBB 1938/00

Sensitivity	1 V
Impedance	20 kOhm
CMRR	>25 dB (50 Hz – 20 kHz)

100 V Input (Screw, unbalanced)

Sensitivity	100 V
Impedance	330 kOhm

Outputs

Line Loop-through Output 1,2 (3-pin XLR, 6.3mm phone jack, balanced)

Nominal Level	1 V
Impedance	Direct Connection to line input

Line loop-through Output 1,2 (3-pin XLR, balanced)

LBB 1938/00

Normal Level	1 V
Impedance	Direct connection to line input

Loudspeaker Outputs (Screw, floating)

Output Power @ 24 V

Battery Operation	-1 dB ref. rated power
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Approvals and Compliance

EMC emission	acc. to EN 55103-1
EMC immunity	acc. to EN 55103-2

CEILING SPEAKER:-**C. Ceiling Speakers should have following features:-**

Features

- . Compact yet powerful
- . Very wide opening angle
- . Installation friendly

- . Comply with international installation and safety regulations

Approval and Compliance

All plastic parts are manufactured from self-extinguishing high-impact ABS material (according to UL 94VO).

Safety	EN 60065
Water protected	acc. to EN 60529 IP x4

Technical Specifications

Max. Power	9 W
Rated Power (PHC)	6 W (6-3-1.5-0.75 W)
Sound Pressure Level at 6 W/1 W (at 1 kHz, 1 m)	96/88 dB (SPL)
Effective Frequency Range	60 Hz to 18 kHz(-10 dB)
Opening Angle	170° / 90° (at 1 kHz/4 kHz, -6 dB)
Rated Voltage	100 V
Rated Impedance	1667 ohm

Mechanical

Speaker Size	101.6 mm (4 in)
Magnet Weight	3.57 oz
Connection	2-pole push connector

Dimensions

Diameter	160 mm (6.30 inch)
Max. Depth	95 mm (3.74 inch)
Ceiling Thickness	9 to 25 mm (0.35 to 0.98 inch)

Mounting Cut-Out	145 mm (5.71 inch)
Color	off-white (RAL 9010)
Weight	690 g (1.52 lb)

Environmental

Ambient Temperature	-25 ⁰ C to +55 ⁰ C (-13 to 131 ⁰ F)
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D. WALL SPEAKER:-**Cabinet Speaker should have following features:-**

1. Good speech intelligibility and background music reproduction
2. Finished in white or black
3. MDB Construction
4. Available with or without integral volume control
5. Complies with international installation and safety regulations

Technical Specification:-**Electrical**

Maximum Power	9 W
Rated Power	6 W (6-3-1.5 W)
Sound Pressure Level at Rated Power/1 W	
(at 1 kHz, 1 m)	99/ 91 dB (SPL)
Effective Frequency Range	180 Hz to 20 kHz (-10 dB)
Opening Angle	
(at 1 kHz / 4 kHz, - 6 dB)	165 ⁰ / 95 ⁰
Horizontal	190 ⁰ / 88 ⁰

Rated input Voltage	100 V
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Rated Impedance	1667 ohm
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Environmental

Ambient Temperature	- 15 ⁰ C to + 55 ⁰ C
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*) Technical performance data acc. to ICE 60268-5

COLUMN SPEAKER:-**Column Speaker should have following features:**

1. For sound Beaming in difficult reverberant conditions
2. Excellent speech and music reproduction
3. Adjustable bracket mounting
4. MDF Construction
5. Comply with international and safety regulations

Technical Specification:-**Electrical**

Max. Power	36 W
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Rated Power	24 W (24-12-6 W)
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Sound Pressure Level at Rated Power/1 W	
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(at 1 kHz, 1 m)	110/96 dB (SPL)
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Effective Frequency Range	165 Hz to 16 kHz (-10 dB)
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Opening Angle	
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(at 1 kHz / 4 kHz, - 6 dB)	
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Horizontal	190 ⁰ / 88 ⁰
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Vertical	30° / 8°
Rated input Voltage	100 V
Rated Impedance	417 ohm

Environmental

Ambient Temperature	- 15°C to + 55°C
---------------------	------------------

E. POWER AMPLIFIER

The main function of the power amplifier is the amplification of audio signals for the signals. It shall be possible to select the output voltage between 100V, 70V, 50V, by changing jumpers. The unit shall be certified to be complaint to IEC 60 849 and compliant to other relevant local standards. Should have the following Features

Mains voltage	115 Vac/230 VAC, ±10%, 50/60 Hz
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Performance

Frequency Response	50 Hz – 20 kHz (+1/-3 dB, @ - 10 dB ref. rated output power,
Distortion	<1% @ rated output power 1 kHz
Bass Control	-8/+ dB @ 100 Hz
Treble Control	-8/+8 dB @ 10 kHz

Inputs

Input 1(5-pin DIN, balanced with phantom power,
6.3 mm phone jack)
Input 2 (3-pin XLR, balanced with phantom power,

6.3 mm phone jack)

Sensitivity 1 m V

Impedance >1 kOhm

S/N (flat at max volume) 63 dB

S/N (flat at min volume/muted) >75 dB

CMRR >40 dB (50Hz-20kHz)

Headroom >25dB

Speech Filter -3 dB @ 315 Hz, high-pass,

6dB/oct

Phantom Power Supply 16 V via 1.2 kOhm

VOX (input 1 only) attack time 150 ms

Release time 2 s

Input 3,4 (3-pin XLR, balanced with phantom power

6.3 mm phone jack)

Sensitivity 1 mV (microphone),

200 mV (line)

Impedance >1 kOhm (microphone),

>5 kOhm (line)

Dynamic Range 100 dB

S/N >63 dB (microphone),

(flat at max volume) >70 dB (line)

S/N >75 dB

(flat at min volume/muted)

CMRR	>40 dB @ (50 Hz-20 kHz)
Headroom	>25 dB
Speech Filter	-3 dB @ 315 Hz, high-pass, 6dB/oct
Phantom Power Supply	16 V via 1.2 kOhm (microphone)
Music Input (Cinch, stereo converted to mono)	
Sensitivity	200 mV

Electrical

Impedance	22 KOhm
S/N (flat at max volume)	>70 dB
S/N (flat at min volume/muted)	>75 dB
Headroom	>25 dB
Emergency/telephone (Screw, balanced)	
Sensitivity	100 m V – 1 V adjustable
Impedance	>10 kOhm
VOX	threshold 50 mV Attack time 150 ms Release time 2 s
S/N (flat at max volume)	>65 dB
Interconnection (Cinch)	
Nominal Level	1 V

Impedance	>10 kOhm
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Outputs

Master output (3-pin XLR, balanced)

Nominal Level	1 V
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Impedance	<100 ohm
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Tape Output (Cinch, 2x mono)

Nominal Level	350 mV
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Impedance	1.5 kOhm
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Interconnection (Cinch)

Nominal Level	1 V
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Impedance	<100 ohm
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Loudspeaker outputs (Screw, floating)

Environmental

Operating Temperature	-10 °C to +45 °C
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Storage Temperature	-40 °C to +70 °C
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Relative Humidity	<95%
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Acoustic Noise Level of Fan	<40 dB SPL @ 1m
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F. BACK GROUND MUSIC & PAGING UNIT:-

Back ground music & Paging unit should have the following features:-

1. All-in-one solution for back ground music & paging.
2. CD player for Audio and MP3 CD/CD – R.
3. FM/AM Tuner with 15 presets and Digital Control.

4. Dual Zone 120W Mixer Amplifier with volume control per zone.
5. Selectable priority and vox switching on microphone input.
6. The powerful 120W out put section has two transformer isolated 100V Constant

Voltage out puts for driving 100V Loud Speakers in two separate zones.

1. The announcement part of the unit has 3 microphone input

Approvals and Compliance

Safety	acc. to EN 60065
Immunity	acc. to EN 55103-2
Emission	acc. to EN 55103-1

Technical Specifications

Mains power supply

Voltage	230/115 VAC, $\pm 15\%$, 50/60 Hz
Max power consumption	25 VA

DVD/CD-Player

Frequency response	2 Hz to 20 kHz (+ 1/-3 dB)
Distortion	<0.1%
S/N	>96dB

MP3

MP3 bit rates	CBR 32 to 320 kbps and VBR, mono and Stereo
Data buffer shock protection	32 MB
Lifetime	>10,000 play cycles

Tuner

Frequency response	30 Hz to 15 kHz (+1/-3dB, FM)
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Distortion	<1%
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Mains power supply

S/N	>63 dB (1mV, FM)
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DVD/CD player outputs

2x

Connector	Cinch, (RCA) stereo
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Nominal level	500 mV
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Optical output	To Slink (PCM, multi channel)
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Supported formats	DVD, CD (re-) writable
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MP3, MP4, JPEG

Mixed output

1x

Connector	Cinch, (RCA) stereo
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Nominal level	200 mV
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Video outputs

Component connectors	3 x cinch
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Composite connector	1 x cinch
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S-Video connector	1 x mini-DIN
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Tuner frequency range

Range	FM 87.5 – 108 MHz
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(Europe, 50 kHz)

87.5 – 108 MHz

(Asia/America, 100 kHz)

AM 531 – 1602 kHz

(Europe, 9 kHz)

530 – 1610 kHz

(Asia/America, 10 kHz)

SensitivityFM 2 μ V (26 dB S/N)AM 30 μ V (20 dB S/N)**Environmental**

Operating temperature -10 °C to +55 °C (14 °F to + 131 °F)

Storage temperature -40 °C to +70 °C (-40°F to + 131 °F)

Relative humidity <95%

G. CALL STATION: -

The call station is used for making a manual or pre recorded call to any pre-assigned zones or executing a pre-defined action. The Call station should have the Following Features.

Features

- . Stylish 6-zone call station, intended for LBB 1990/00 voice Alarm System Controller
- . Six zone selection keys, all-call key and momentary PTT-key for calls
- . Selectable gain, speech filter and limiter for improved

- . intelligibility
- . LED indications for zone selection, fault and emergency state
- . Call station extension provides 7 additional zone and zone group keys

Technical Specification

Power supply

Voltage Range	18 – 24 V
	24 V by
	LBB 1990/00
	Or external power supply
Current Consumption	<30 mA Call Station
	<15 mA key Pad

Performance

Nominal Sensitivity	85 dB SPL (gain preset 0 dB)
Nominal Output Level	700 mV
Maximum Input Sound Level	110 dB SPL
Gain Preset	+6/0/-15 dB
Limiter Threshold	2 V
Compression Ratio Limiter	20 : 1
Distortion	<0.6% (maximum input)
Equivalent Input Noise Level	25 dB SPLA
Frequency Response	100 Hz – 16 kHz
Speech Filter	-3 dB @ 315 Hz, high-pass,

6 dB / oct

Output Impedance 200 ohms

Selections

Environmental

Operating Temperature -10 °C to +55 °C

Storage Temperature -40 °C to +70°C

Relative Humidity <95%

Conduiting and Wiring Installation Work**Galvanized Iron (G.I) Pipes and Accessories**

Galvanized iron pipes shall be used on surface or underground installation wherever specified and required at entry into manholes and as shown on drawings.

The underground G.I. pipes and accessories shall be provided with one thick coat of bituminous paints on the outer surface prior to installation.

PVC Conduit and Accessories for Indoor

The PVC bends shall have enlarged ends to receive conduit without any reduction in the internal diameter at joint. Manufactured smooth bends shall be used where conduit changes direction. Bending of conduits by heating or otherwise will be allowed in special situations only for which the consent of the Engineer shall be required. The use of sharp 90 degree bends and tees will not be allowed for concealed wiring.

The round PVC junction boxes for ceiling shall have minimum dimensions of 63 mm diameter and depth. Wall junction boxes shall have minimum dimensions of 63 mm deep. Round junction boxes means of brass screws

Pull and Adaptable Boxes

Inspection/Pull boxes and adaptable boxes shall be provided in conduit runs wherever required to facilitate pulling operation. The drawings are diagrammatic and do not indicate the position and spacing of inspection/pull boxes or adaptable boxes. However, these shall be as per Engineer's approval.

Cable for Public Address Systems

The cables shall be PVC insulated, PVC sheathed twisted pair screened copper conductor conforming to IEC

The PVC insulation shall comply with BS 6746. The conductor shall be tinned soft high conductivity soft annealed copper complying with 6360. The insulation of conductors shall be colour coded as per above-mentioned publications.

All wires and cables shall be color-coded tagged and checked for open short or ground terminals blocks of proper size and type for the services involved cable joints shall only be allowed on speaker and

Rack

Suitable mounting rack for head and equipment with adequate ventilation to fixing of all controlling equipment .

Testing & Commissioning

On completion of the work and before commissioning of the equipment. The entire PA /sound system including wiring shall be tested and commission by the supplier / sub-contractor engineer and test performance result to be submitted to client / user and system commission report.

Maintenance & Warranty

The supplier / CONTRACTOR shall be responsible for all equipment by him and warranty the time for a period of twelve month from the date of commissioning certificate.

Training

The supplier / CONTRACTOR shall provide

SECTION – 19 CCTV SYSTEM**19.1 SCOPE OF WORK**

The work under this section consists of, installation, testing and commissioning a complete closed circuit television (CCTV) system as stated herein and as per SCHEDULE OF VALUES..

All equipment provided under this section shall conform to relevant European / American standard i.e. CE & UL listed..

19.2 MATERIALS

The system shall provide color CCTV surveillance of specified areas by means of color CCD cameras. The Control Contain the color monitor with Digital Video Recorder.

A. Camera.

Compact rugged, 1/3 inch image format digital color CCD cameras having a resolution of 752 (horizontal) by 582 (vertical) pixels is specified. The Camera shall conform to the CCIR – standard. The camera shall be of compact rugged design, high sensitivity advance digital signal processing high resolution with outstanding picture quality extended sensitivity with night sense.

The camera shall require only 1.0 lux for useable video. All the control shall be concealed. Other standard features shall be back light compensation, automatic shutter, selectable electronic shutter, digital adjustment control, automatic white balance and insulation installation.

The camera shall be line locked to the power line zero crossing to ensure roll free vertical interval video switching and recording.' A vertical phase adjustment potentiometer shall be accessible through an opening in the side of camera to allow for camera synchronization in multi phase power installation.

The rated voltage shall 12VDC, 24VAC, 50 Hz. The operating temperature shall be -20 to 50 degrees Celsius. Humidity shall be 5 to 93 % non-condensing. Shock resistance shall be minimum 50 gm.

Signal-to-Noise Ratio: 50 db with AGC : 21 dB (Max.)

Electronic Shutter: Automatic, 1/50 to 1/125,000 – sec.

White Balance: Automatic Sensing, (2500 – 9000 K)

Video Output Composite video 1.0 Vpp, 75 ohms)

The camera should have an on-screen menu with following controls.

Video Level

AGC: : On / Off
 BLC : On / Off
 ATW : On / Hold
 Shutter : AES/ off / Flicker less.
 R – Offset
 B – Offset
 V – Phase Adjustment: 0 –358 Degrees

B. Auto Dome Camera.

The camera should consist an imager of 1/3" IT CCD with a resolution of (752 x 582 " PAL) / (768 x 494 NTSC). Having a lens of 25 x zoom (2.4 :- 60 mm) F 1.6 to F 27. It ' should consist an automatic with manual override. Focus and iris adjustment with a field of view of 2.0 degree to 45 degree.

The camera should be operational between -40 degree C to 50 degree C under 100% relative condensing humidity, the ingress protection should be less than IP 66 (NEMA 4X)

The camera should be able to PAN 360 degree continues and tilt from horizontal plane 5 degree to 90 degree during a guard tour the camera speed should be 360 degree per second, ISO accuracy and having a variable speed of 120 degree per second.

The camera should be capable of creating 16 independent sector with 16-character title. The camera should be remotely controlled through either biphaser or via RS-232. Pre position should be at least 99 each with 16-character title.

The camera can create two types of tours one recorded tour with totally 15 min during both and the preset tour that consist up to 99 scenes consecutively. The camera should be able to fast addressing or 4 digit thumb wheel.

The camera must have the following specification.

Video output	:	1.0 Vp-p ; 75 ohms
Gain control	:	off / auto (with adjustable limit)
Synchronization	:	line lock (-120 to 120 degree vertical phase adjust) or internal crystal
Aperture Correction	:	horizontal and vertical
Digital zoom	:	12 X
Horizontal resolution	:	470 TVL (NTSC) / 460 TVL (PAL)
Sensitivity (usable video)		
Day mode w/slow shutter off		0.2 fc / 2.0 Lx
Night mode w/slow shutter on		0.025 fc / 0.25 Lx
Day mode w/slow shutter on		0.013 fc / 0.13 Lx
Night mode w/slow shutter off		0.0016 fc / 0.016 Lx

C. AUTO DOME CONTROLLER:

Auto Dome Controllers provide complete Control of the Auto Dome System features is as:

- Operates upto 8 Controllable Cameras in daisy -Chain Configuration.
- Controls All Dome system features including Auto play back
- Ergonomic layout for single-handed Control.
- Full pan/tilt/zoom operation
- 22, key control unit with integral vector solving 'pan/title/zoom/joy stick, interface box and appropriate power supply.

D. CCTV MONITOR

Color Monitor is multi standard compatibility with a Built - in loud speaker and inputs able to accept NTSC, PAL and S-video standards in 450 TV line of Horizontal resolution is housed in a compact, space-saving metal cabinet for, rugged reliability.

E. Digital Video Recorder:

- Digital video recorder should have the following features. ~ Combined multiplexer & digital video recorder.
- 240 fps recording (PAL/NTSC)
- Simultaneous recording & play back.
- Remote operation via the control center.
- Intuitive user face.
- Storage capacity of upto 7 day recording

F. VIDEO CABLE

The Low loss video cable RG - 6 are 75 ohms coaxial cables suitable for use in close circuit television system. The specifications adopting such design is mentioned below.

- The conductor shall be copper.
- The insulation comprises of foamed polyethylene resulting in low attenuation.
- Cable is then provided with screen and overall covered with black PVC compound.

G. POWER CABLE

PVC insulated PVC sheathed unarmored multicore 600 ' / 1000 volts grade with standard copper conductors according to latest standard specification.

H. LENSES

Lenses shall be of C and CS mount and following types.

1. 4 or 8 mm fixed focal length and manual iris lens.
2. 3.5 - 8 mm varifocal auto iris lens.

I. RACK.

The rack shall house monitors, Digital Video Recorder. It shall be of 19" standard mounting system, all material casing with front glass Door. All racks shall be supplied with lock & key arrangement.

19.3 TESTING & COMMISSIONING.

All of the normal test as recommended by the manufacturer shall be carried out on the system. The system shall be commissioned by the authorized personnel only.

SECTION – 22 TESTING AND COMMISSIONING

22.1 SCOPE

Upon completion of the installation the CONTRACTOR shall perform field tests on all equipment, material and systems. All tests shall be conducted in the presence of the Engineer for the purpose of demonstration equipment or system compliance with specifications.

The CONTRACTOR shall furnish, install and maintain all tools, instruments, test equipment, material, connections, etc., and furnish all personnel including supervision and 'Stand by" labor required for the testing, setting and adjustment of all electrical facilities and their component parts, including putting the same into operation.

All tests shall be made with the proper regard for the protection of the equipment, and the CONTRACTOR shall be responsible for adequate protection to all personnel during such tests.

The CONTRACTOR shall record all test values of the tests made by him on all equipment, giving both "as found" and 'as left" conditions. Three (3) copies of all test data shall be given to the Engineer for record purposes.

The witnessing of any test by the Engineer do not relieve the CONTRACTOR of his guarantees for materials, equipment and workmanship as specified in the Conditions of Contract.

This Section includes general requirements for field testing and inspection of electrical systems. More detailed requirements are specified in each Section listed in the "Related Sections" paragraph. General requirements include the following:

1. Qualifications of testing agencies and their personnel.
2. Suitability of test equipment.
3. Calibration of test instruments.
4. Coordination requirements for testing and inspecting.
5. Reporting requirements for testing and inspecting.

22.2 TYPE OF TESTS

T.1 INSULATION TESTS.

Insulation resistance tests shall be made on all electrical equipment, using a self-contained instrument such as the direct indicating ohm-meter of the generator type direct current potentials shall be used in these tests shall be as follows :-

Circuit under 230 volts - 500 volts test.

Circuit 230 volts to 400 volts-1000 volts test.

The minimum acceptable insulation resistance value will be 5 Megaohms.

The test equipment for insulation testing will be furnished by the CONTRACTOR.

Before making connections at the ends of each cable run, the insulation resistance test of each cable shall be made. Each conductor of a multicore cable shall be tested individually to each other conductor of the group and also to earth. If insulation resistance test readings are found to be less than the specified minimum in any conductor, the entire cable shall be replaced and the new cable tested.

All transformers, switchgear shall be given an insulation resistance measurement test to ground after installation but before any wiring is energized. Insulation tests shall be made between open contacts of circuit breakers, switches and between each phase and earth.

If the insulation resistance of the circuit under test is less than that specified above, the cause of the low reading shall be determined and removed. Corrective measure shall include dry out procedure by means of heaters if equipment is found to contain moisture. Where corrective measures have been necessary and the insulation resistance reading taken after the correction has been made it should satisfy the requirements specified herein. Repeated insulation resistance maintenance test shall be made twice and at least 12 hours apart. The maximum range for each reading on the 3 successive tests shall not exceed 20% of the average value. After all tests have been made successfully , the equipment shall be reconnected.

T.2 EARTH RESISTANCE TESTS.

Earth resistance tests shall be made by the CONTRACTOR on the earthing system, separating and re-connecting each earth connection as may be required by the Engineer. If it is indicated that soil treatment or other corrective measures

are required to lower the ground resistance values, the Engineer will determine the extent of such corrective measures.

The electrical resistance of the ECP together with the resistance of the earthing lead measured from the connection with earth electrode to any other position in the completed installation shall not exceed **one ohm**.

Earth resistance test shall be performed as per Electrical Inspector's requirements. Where more than one earthing sets are installed, the earth resistance test between two sets shall be measured by means of resistance bridge instrument. The earth resistance between two sets shall not exceed one ohm.

T.3 TRANSFORMER & SWITCHGEAR.

In addition to the insulation resistance tests on the transformer, a polarity or phase rotation test shall also be made. Auxiliary devices, breather, bucholz relay etc. shall be tested for satisfactory operation.

Each air circuit breaker shall be operated electrically and mechanically, ascertaining that handle mechanisms are operating. All interlock control circuit shall be checked out for proper connections in accordance with the wiring diagrams given by the manufacturer.

The CONTRACTOR shall identify the phase of all switchgear and power cables by stenciling the switchgear and tagging the cables so that the phases can be identified for connections to give proper phase sequence.

Series over current trip elements shall be checked against rating of equipment served. Also to be checked for correct size, function of fuses disconnect switches, number of interlocks indicating lights, alarms and remote control devices. Name plates shall be checked for proper designation of equipment served.

T.4 OPERATING TESTS.

Current load measurement shall be made on equipment and on all power and lighting feeders.

The current reading shall be taken in each phase wire and in each neutral wire while the circuit or equipment is operating under actual load conditions. Clip-on ammeters may be used to take current readings. All light fittings shall be tested electrically and mechanically to check whether they comply with the standard of specifications. Fluorescent light fittings shall be tested so that when functioning properly no flickering is observed or choke noise is heard.

The lightning protection system shall be tested for earth resistance and for electrical and mechanical joints. The combined resistance to earth to the whole lightning protection system shall not exceed 5 ohms.

The alarm system, telephone system, sound distribution system shall be checked and tested as per manufacturer's instructions and in the presence of the Engineer or his representative.

After any equipment has been tested , checked for operation etc., and is accepted by the Owner's representative the CONTRACTOR shall be responsible for the proper protection of such equipment for assurance that subsequent testing of other equipment of system do not disturb the completed work.

22.3 GENERAL TESTS AND INSPECTIONS

- A. Testing Preparation: Prepare systems, equipment, and components for tests and inspections, and perform preliminary tests to ensure that systems, equipment, and components are ready for Independent Testing Agency testing. Include the following minimum preparations as appropriate:
 - 1. Perform insulation-resistance tests.
 - 2. Perform continuity tests.
 - 3. Perform rotation test (for motors to be tested).
 - 4. Provide a stable source of electrical power for test instrumentation at each test location.
- B. Field Test and Inspection Reporting: In addition to requirements specified in Related Sections, ensure that each test and inspection report includes the following:
 - 1. Manufacturer's written testing and inspecting instructions.
 - 2. Calibration and adjustment settings of adjustable and interchangeable devices involved in tests.
 - 3. Tabulation of expected measurement results made before measurements.
 - 4. Tabulation of "as-found" and "as-left" measurement and observation results.

END OF THE SECTION

ANNEXURE 01

LIST OF APPROVED MANUFACTURERS

Approved Manufacturer List (Civil Works)

Sr.No.	Item	Manufacturer
1	Fill Material	<ul style="list-style-type: none"> Local Sand
2	Back fill (Crush stone Under Floor)	<ul style="list-style-type: none"> Local
3	Cement	<ul style="list-style-type: none"> Bestway Cement Ltd Cherat Cement Kohat Cement Askari Cement Or Approved Equivalent
4	Steel Reinforcement	<ul style="list-style-type: none"> Karachi Steel Islamabad Ittehad Steel Islamabad Fazal Steel Islamabad Nomee Steel Hattar KPK FF Steel Or Approved Equivalent
5	Fine Aggregates (Sand)	<ul style="list-style-type: none"> Lawrancepur Qibla Bandi Ghazi Or Approved Equivalent
6	Coarse Aggregate (Crush)	<ul style="list-style-type: none"> Margalla Kacha Morr Or Approved Equivalent
7	Concrete Blocks	<ul style="list-style-type: none"> Concrete Concept Pvt Ltd Hubcrete Pvt Ltd Banu Mukhtar concrete Pvt Ltd Or Approved Equivalent
8	Inter Lock Pavers	<ul style="list-style-type: none"> Concrete Concept Pvt Ltd Hubcrete Pvt Ltd Banu Mukhtar concrete Pvt Ltd Or Approved Equivalent
9	Kerb Stone	<ul style="list-style-type: none"> Concrete Concept Pvt Ltd Hubcrete Pvt Ltd Banu Mukhtar concrete Pvt Ltd Or Approved Equivalent
10	Terracotta Brick Tile	<ul style="list-style-type: none"> Roshan Bricks Shabir Bricks Pak Clay Industry Or Approved Equivalent
11	Sand Stone	<ul style="list-style-type: none"> Approved Sand Stone
12	Jumbolon board	<ul style="list-style-type: none"> Diamond jumbolon board Or Approved Equivalent
13	Water Stopper	<ul style="list-style-type: none"> Decora Plastics Marflex Or Approved Equivalent

Sr.No.	Item	Manufacturer
14	Anti Termite Treatment	<ul style="list-style-type: none"> • Mirage (Ali Akbar Group) • Agenda (Bayer) • Bioplex Or Approved Equivalent
15	Construction Chemical , Sealant & Clean room	<ul style="list-style-type: none"> • Sika Pakistan Pvt Ltd • Ultimate Construction Pvt Ltd (BASF) • Mitchell Chemical Pvt Ltd • Or Approved Equivalent
16	Paint, Lacquer / Varnishes	<ul style="list-style-type: none"> • ICI • Jotun • Berger • Or Approved Equivalent
17	Bitumen	<ul style="list-style-type: none"> • National Refinery Limited
18	Bituminous Membrane	<ul style="list-style-type: none"> • Hy-Grip • Roof Grip • Or Approved Equivalent
19	Aluminum	<ul style="list-style-type: none"> • Pakistan Cable • Prime Aluminum • Chawla Aluminum • Pak-Altek • Or Approved Equivalent
20	Glass Clear 12mm (Local)	<ul style="list-style-type: none"> • Ghani Group of Companies • Tariq Glass Industries Ltd • Gunj Glass • Or Approved Equivalent
21	Glass 6mm (Local)	<ul style="list-style-type: none"> • Ghani Group of Companies • Tariq Glass Industries Ltd • Gunj Glass • Or Approved Equivalent
22	Frosted / Safety Film	<ul style="list-style-type: none"> • 3M Or Approved Equivalent
23	Porcelain Tile	<ul style="list-style-type: none"> • Shabir (S-Tiles.) • Master Tiles. • Sonex Tiles • Time Ceramics Tiles • Or Approved Equivalent
24	Tile Bond	<ul style="list-style-type: none"> • Style (Shabbir Tiles) • Abe pak Construction Chemicals • Or Approved Equivalent
27	False Ceiling (Gypsum Board)	<ul style="list-style-type: none"> • Elephant Thailand • USG Thailand • DFB Gypsum • Or Approved Equivalent
29	Thermopore Sheet	<ul style="list-style-type: none"> • Industrial Enterprises • Insulation Advocate Or Approved Equivalent
30	Cast Iron Manhole Cover	<ul style="list-style-type: none"> • Teepu Pipe & Fittings • Alpine Steel Pvt Ltd • Or Approved Equivalent

31	Granite	<ul style="list-style-type: none">• Uhad Granite• Capital Marble• Haqeeq Marbles• Naseem Marble• Or Approved Equivalent
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Sr.No.	Item	Manufacturer
32	Floor and Wall Tiles	<ul style="list-style-type: none">• SONEX• MASTER• STYLE• Time Ceramics• Or Approved Equivalent

Approved Manufacturer List
(Public Health Works)

Sr.No.	Item	Manufacturers
1	UPVC Pipe SWV	<ul style="list-style-type: none"> DadexEternit Ltd Beta pipe Popular (waheed Shahzad) Royal PVC Master • Or Approved Equivalent
2	UPVC Pipe Fittings	<ul style="list-style-type: none"> DadexEternit Ltd Beta pipe Popular (waheed Shahzad) Royal PVC Master • Or Approved Equivalent
3	Plumbing pumps	<ul style="list-style-type: none"> HMA Pumps Pvt Ltd (Grundfos) KSB Pump Pvt Ltd • Or Approved Equivalent
4	PPRC Pipes	<ul style="list-style-type: none"> DadexEternit Ltd Beta pipe Popular (waheed Shahzad) Royal PVC Master • Or Approved Equivalent
5	PPRC Pipe Fittings	<ul style="list-style-type: none"> DadexEternit Ltd Beta pipe Popular (waheed Shahzad) Royal PVC Master • Or Approved Equivalent
6	Pipe Hanging System	<ul style="list-style-type: none"> Sikla Fisher • Or Approved Equivalent Hilty
7	G.I Pipes	<ul style="list-style-type: none"> IIL Pvt Ltd • Or Approved Equivalent Jamal Pipe Industries
8	G.I Pipes Fittings	<ul style="list-style-type: none"> H.E China T.G China Or Approved Equivalent
9	MS Schedule 40 pipe	<ul style="list-style-type: none"> Huffaz Pvt Ltd Or Approved Equivalent Jamal pipes industries
10	HDPE Pipe	<ul style="list-style-type: none"> DadexEternit Ltd Beta pipe Popular (waheed Shahzad) Royal PVC Master • Or Approved Equivalent
11	Sanitary Ware	<ul style="list-style-type: none"> Durr ICL Pak Made Approved quality • Or Approved Equivalent
12	Kitchen/ Lab Sink	<ul style="list-style-type: none"> Super Asia Atlas Rashid Industries • Or Approved Equivalent

13	Sanitary Fitting Fixtures	<ul style="list-style-type: none">• Master• Sonex• Faisal• Or Approved Equivalent

Approved Manufacturer List
(HVAC Works)

1 TRANSFORMER

- i) PEL
- ii) SIEMENS
- iii) ELMATEC
- iv) Or Approved Equivalent

2 LT-PANELS, METERING PANELS & DB's

- i) Tariq Brothers,
- ii) JEI
- iii) Master Electric.
- iv) Electrech.
- v) Capital Electro
- vi) JEI
- vii) United Engineering
Peshawar.
- viii) Or Approved Equivalent

3 CIRCUIT BREAKERS

a) TP MCCBS

- i) SCHNEIDER (FRANCE)
- ii) ABB (ITALY)
- iii) Or Approved Equivalent

b) SP MCBS / ELCBS

- i) SCHNEIDER (FRANCE)
- ii) ABB (ITALY)
- iii) Or Approved Equivalent

4 CONTACTORS

- i) SCHNEIDER (FRANCE)
- ii) ABB (ITALY)
- iii) Or Approved Equivalent

5 SELECTOR SWITCHES

- i) BRETER (ITALY)
- ii) KRAUS & NAIMER (NEWZEALAND/AUSTRIA)
- iii) Or Approved Equivalent

6 VOLTMETER, AMPEREMETERS

- i) Entes
- ii) Sigma
- iii) C-XOR Engineering
- iv) Or Approved Equivalent

Turkey

Turkey

7 INDICATION LIGHTS

- i) TELEMECHANIC
- ii) HAGER
- iii) Or Approved Equivalent

8 TERMINAL BLOCKS

- i) LEGRAND
- ii) ONKA
- iii) Or Approved Equivalent

9 CURRENT TRANSFORMER

- i) REVALCO
- ii) NITECH
- iii) DIXCON
- iv) Or Approved Equivalent

10 ON/OFF PUSHBUTTON

- i) MARUYASU
- ii) FUJI
- iii) GE
- iv) Or Approved Equivalent

(JAPAN)

(JAPAN)

(EU)

11 AUXILIARY CONTACTOR RELAY

- i) SIEMENS
- ii) ABB
- iii) GE
- iv) Or Approved Equivalent

(GERMANY)

12 Surge Protection Devices

- i) Leutron
- C-Xor Engineering 042-36126722
- ii) PHONIX
- iii) Or Approved Equivalent

(GERMANY)

13 LT CABLES

- i) PAKISTAN CABLES
- ii) NEWAGE CABLES
- iii) AGE Cables
- iv) FAST Cables.
- v) Allied Cables.
- vi) Or approved equivalent.

14 PVC CONDUIT & ACCESSORIES

- i) POPULAR PIPES
- ii) ADAM JEE
- iii) SHAYVAL
- iv) Royal PVC
- v) Or approved equivalent.

15 LIGHTING FIXTURES

- i) SUN LIGHT PAKISTAN
- ii) BRITTLITE
- iii) PIERLITE
- iv) PHILLIPS
- v) Future Technology
- vi) Orient
- vii) Or approved equivalent.

16 SWITCHES, SOCKETS & INDUSTRIAL SOCKETS

- i) SCHNIEDER
- CLIPSAL PAKISTAN
- ii) ABB
- iii) Legrand.
- iv) MKI
- v) Or approved equivalent.

17 FIRE ALARMSYSTEM

i) HONEYWELL (USA)

DIGITAL PLUS

PH:- 042-35755076

ii) MENVER (UK)

M/S AL-KARAM INTERNATIONAL

PH:- 051-5514707, 051-5513470, 0300-8562706

NORDEN(UK)

ii) M/S APCON ENGINEERING

Ph:- 042-35226183, 35035721

a) DAHUA TECHNOLOGIES

i) ASTAA TECHNOLOGIES

PH:- 042-35761062

b) SAMSUNG

iii) VITAL INTERNATIONAL

PH:-042-35290613-14

iv) DIGI WATCH SOLUTION

PH:- 042-35861737

Or approved equivalent.