VOLUME - IV

SPECIFICATION

FOR

INTERIOR RENOVATION OF SECP CRO, 3RD &4TH FLOOR, ASSOCIATED HOUSE, EGERTON ROAD, LAHORE

Issued To : _____

Issued On : _____

Sign of Issuing Officer : _____

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

DEMOLITION WORKS

1 SCOPE

– The work covered by this section of the specifications consists of removal of Brick Work, Wood Work, Plumbing Items, Electrical Items, and debris of bathrooms, and performing all operations as required to dismantle existing CRO Interior Works of 3rd and 4th floor, Associated House, Egerton Road, Lahore, as per the method statement submitted during or before prequalification with all necessary required precautions or as directed by the Engineer.

2 SUBMITTALS

2.1 Method Statement and Details

For all Demolition works the Contractor shall submit for the prior approval of the Engineer, the methodology and list of plant and equipment to be employed on the Works. No work shall be commenced until the methodology, plant and equipment to be used in the Works is approved by the Engineer.

3 DISMANTLING PROCEDURES

3.1 Demolitions shall be performed in an orderly manner and the Contractor shall take all necessary precautions and expedients to prevent damages to the adjacent structures.

3.2 Explosives shall not be used to remove or demolish the Plain and Reinforced Cement Concrete Structures unless otherwise directed by the Engineer.

4 EXECUTION

4.1 Description of Site

The Contractor shall take sufficient steps/ actions/ measures for the safety of the adjoining building and shall be sole responsible for any damage to the existing superstructures and substructures caused due to demolition. Client and Consultant shall not be responsible for any misshape due to poor execution.

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 where demolition and transportation is in progress.

4.2 Notice to Commence Work

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

4.3 **Demolitions near Existing Buildings**

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

4.4 Shoring, Planking and Strutting

Shoring, where required during demolition, shall be installed to protect workmen and 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. Any damage to the property on account of Contractor's fault shall be solely on his account.

4.4 **Utility Lines**

Existing utility lines that are visible or the locations of which are made known to the Contractor prior to demolition and that are to be retained, as well as utility lines constructed during dismantling if damaged, shall be repaired by the Contractor at his own expense. 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. The utility lines, which are to be removed, are encountered within the area of operations the Contractor shall notify the Engineer in ample time for the necessary measures to be taken to prevent interruption of the service.

4.5 **Stockpiling of Demolished Materials**

Demolished material suitable for reusable may be stockpiled as directed by the Engineer.

5 DISPOSAL

5.1 The demolished/rejected debris materials shall be broken to pieces not larger than 25 to 75mm

5.2 All materials resulting from Demolition shall be disposed off out of Municipal limits along the most direct route from the boundary of the project and/or as directed by the Engineer

5.3 All carts, trucks or other vehicles used by the Contractor for transportation of the Dismantled/Demolished material shall be suitably constructed or lined so as not to permit any leakage of materials while the vehicles are on the move. These would be so loaded and arranged as not to spill on the Site and public roads. Whenever any vehicle so used is found leaking and unsuitable it shall be immediately withdrawn from the Work.

5.4 The disposal of Dismantled/Demolished debris material shall include loading, unloading, transporting, spreading and leveling as directed by the Engineer

6 PROPERTY OF MATERIAL

All the materials designated as reusable Except Electrical & Mechanical fixtures at the opening date of tender shall be the property of the Contractor and stacked/stored in an approved manner at a place within the site area as approved by the Engineer.

7 MEASUREMENT AND PAYMENT

7.1 General

Except otherwise specified herein or elsewhere in the Contract Documents, no measurement and payment will be made for the under-mentioned works related to the relevant BOQ item.

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

7.1.2 Stacking of reusable materials.

7.1.3 Operations and the steps taken for the safety of the existing adjoining structures including danger direction/ diversion sign boards of appropriate size and temporary segregating the area with corrugated sheet steel plates or with brick masonry in mud.

7.1.4 Temporary diversion of existing utility lines.

7.1.5 Disposal of demolished debris materials out of Municipal limits including loading unloading and spreading.

7.1.6 Arrangement of water and power supply for the works, if required.

7.1.7 Tools, Plants and equipment used for the demolition.

7.1.8 Any damage caused to the structures and installation due to negligence of the Contractors during dismantling operations and their repair/replacement. to the satisfaction of the Engineer.

7.1.9 Cleaning and restoring the site to the satisfaction of the Engineer.

7.2 Measurement and payment

No payment will be made to the contractor. It is deemed that price of reusable materials such as bricks, Doors, Windows, etc; are in excess to the price of demolition and other liabilities of the contractor as mentioned above therefore the contractor will credit a lump sum amount to the Employer as quoted in Bill of Quantities.

TERMITE CONTROL TREATMENT

1 SCOPE

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

2 CODES AND STANDARDS

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

3 SUBMITTALS

3.1 Samples of all the materials to be used for termite control for approval of the Engineer and testing in accordance with the specified standards.

3.2 Method statement for application of anti-termite chemical.

4 QUALITY ASSURANCE

4.1 Manufacturer's Instructions

In addition to the requirements of these specifications, the manufacturer's instructions and recommendations for the work, including preparation of substrata and application shall be complied with.

4.2 Application

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

4.3 Guarantee

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

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

5 MATERIAL

5.1 An emulsible concentrated 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 one of the following chemical with clean portable water in ratio 1:40 unless otherwise specified by the manufacturer/ supplier.

5.1.1.1 Termidor

5.1.1.2 Biflex

5.1.1.3 Dursban

5.2 Insecticide shall be obtained from the Sole distributor, in sealed drums in quantity necessary for the requirement of works.

All mixing shall be done at site and mixing proportion of insecticide with water shall be verified by the Engineer.

5.3 Pure turpentine shall be used for dilution of insecticide, in approved proportion for application to woodwork where such application is required.

6 METHOD AND EXTENT OF APPLICATION

6.1 Insecticide solution shall be applied with approved pressure spraying equipment maintaining a pressure of 150psi to all applications to, on or in earth.

6.2 Soil treatment shall begin after all work of preparation of earth prior to installation of concrete has been done. After application, no additional earth moving or work upon sub grade should be done. No covering of earth or concrete should be applied over soil treatment until at least 24 hours after treatment has been made. 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 2 meter beyond building line. Solution shall be applied in amounts of not less than 6.00 litter /sq.m of area. If applied over gravel or sand fill, application shall not be less than 7.50litre /sq.metre of area. Insecticide shall penetrate to a depth of 25-mm minimum in porous earth at bottom and 50 mm to 75 mm at sides of excavations.

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

6.4 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.

6.5 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.

6.6 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.

7 MEASUREMENT & PAYMENT

7.1 General

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

7.1.1 Termite control treatment on wood works.

7.1.2 Turpentine & Water required for mixing insecticide solution.

7.1.3 Transportation of material and storage at site.

7.1.4 Anti-termite treatment on stock piled backfill material.

7.1.5 Tool, plant & equipment required for Termite control treatment

7.2 Termite Control Treatment

7.2.1 Measurement

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

7.2.2 Payment

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

BRICK MASONRY

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 connection with furnishing and installing plain Brick Masonry and fair face Brick cladding (Gutka) of specified size in position complete in strict accordance with this section of the specifications and applicable drawings and or as established by the Engineer.

2 CODES AND STANDARDS

The work shall conform to the requirements of the following Codes and Standards, unless otherwise specified.

ACI 530-88	Building code requirements for masonry structures
ACI 530.1-88	Specifications for masonry structures
PS 208	Classification, strength and properties of bricks.
ASTM C 67-81	Standard method for sampling and testing brick and structural clay tile.
ASTM C 144-81	Standard specifications of aggregates for masonry mortar.
ASTM C 150-81	Specifications for Portland cement
UBC 2405	Quality control
UBC 2406	Allowable stresses

3 SUBMITTALS

The Contractor shall submit the following to the Engineer for his approval:

3.1 Methodology and Sequence of work.

3.2 Specimen samples of bricks, aggregates for mortar or grout and Portland cement. Specimens of bricks shall be representative of a complete range of Colors, textures and sizes.

3.3 Results of all the tests performed upon the materials and masonry units obtained from the site of work as per directions of the Engineer.

4 TOLERANCES

4.1.1 Brick

No overall dimension of brick (width, height and length) shall differ from the specified standard dimension by more than 1/8 inch (3 mm). Standard dimensions of brick is 9” x 4-1/2” x 3” (230 x 115 x 75mm) and fair face brick (gutka) is 9” x 2-1/4”” x 2-1/4” (230 x 62 x 62 mm).

4.1.2 Brick Work

All brick work shall be erected true to line, plumb and level and the variation:

4.1.2.1 from plumb in any length of wall shall not exceed 1/12” (2mm) in 3 feet (one metre) or 3/8” (10mm) in a storey height or 1 inch.(25mm) in the entire height.

5 INSPECTION AND TESTING

Regular inspections shall be carried out to control the quality of the works and to ensure that materials, construction and workmanship are in compliance with the plans and Specifications. Inspection and test records shall be maintained and made available to the Engineer as a routine, on each working day.

5.1 Inspection

Inspection for quality control shall include, but is not limited to the following:

5.1.1 the masonry units i.e. bricks, reinforcement if used, cement, lime, surkhi, aggregate, water and all the other materials meet the requirements of the applicable standards of quality

5.1.2 materials are properly stored and prepared for use

5.1.3 mortar and grout are properly mixed using specified proportions of ingredients,

5.1.4 the method of measuring materials for mortar and grout shall be such that the proportions of the constituents are entirely controlled.

5.1.5 the bricks pass a visual inspection for soundness, compact structure, reasonably uniform texture and shape; and that the bricks are free from cracks, warpage, large pebbles, balls of clay or particles of lime that would affect the serviceability or strength of the brick.

5.2 Testing

Burnt bricks shall be of uniform Color, finish and free from cracks, warpage, exposed stones, pebbles or particles of lime. The size of the bricks shall be in accordance with that shown on the Drawings. The testing of bricks shall comply with ASTM C 67. Physical requirements of the bricks shall be as given in Table 4A-1

TABLE 4A-1

Bricks	Minimum Compressive Strength (brick flat wise)	Maximum water Absorption in 5 hour	Maximum Saturation Co-efficient
Individual	(1,150 psi) 8 MPa	25%	0.90
Average of 5 bricks	(1,430 psi) 10 MPa	22%	0.88

The saturation coefficient is the ratio of absorption by 24 hours submersion in cold water and to that after 5 - hours submersion in boiling water.

In case the bricks do not have the compressive strength as specified then the Engineer shall use his best judgment in permitting incorporation of the best bricks available in the area, taking into consideration the nature and structural stability of the works.

If 10 bricks per thousand are defective or if the average weight of nominal 9" x 4-1/2" x 3" (230 mmx115x75mm) brick is less than 3.5 kg or the bricks are out

of dimension the whole lot shall be rejected and the Contractor shall remove the rejected lots from the Site.

6. DELIVERY AND STORAGE

6.1.1 Delivery

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.

6.1.2 Storage

Masonry materials shall be so stored that at the time of use the materials are clean and structurally suitable for use.

7 MORTAR

7.1 Cement

All cement for mortar for brickwork shall conform to the applicable requirements set forth in Section Plain and Reinforced Concrete.

7.2 Sand

Sand for mortar used in brickwork shall be furnished by the Contractor, and shall meet the requirements set forth in ASTM C 144. The Fineness Modules of the sand shall range between 1.9 to 2.8 and the grading shall be within the limits given in Table

TABLE 4A-2

Sieve Sizes		**Percent Passing (by weight)**
4.76mm	No. 4	100
2.38mm	No. 8	95 to 100
1.18mm	No.16	70 to 100
600um	No.30	40 to 75
300um	No.50	10 to 35
149um	No.100	max. 25
74um	No.200	max. 10

Sand shall be stored at the Site in such a manner that it is not mixed with foreign matter. Methods employed by the Contractor for unloading, loading, handling and storage shall be subject to the approval of the Engineer. Sufficient quantity shall be maintained at the Site at all times to assure continuous work.

7.3 Water

The water used in the manufacture of bricks and in the preparation of mortar shall be in complete conformity with the applicable requirements set forth for water in Section Plain and Reinforced Concrete.

7.4 Surkhi

Surkhi shall be prepared by grinding special bricks into powder form or may be obtained/purchased from approved manufacturers.

7.5 **Mortar Composition**

7.5.1 **Cement Sand Mortar**.

Mortar for all brickwork shall, except as otherwise specified or directed by the Engineer, shall consist of one part Portland Cement to four parts of sand by volume for 4-1/2" (115 mm) thick walls and one part of cement in six parts of sand for 9" (230mm) and over thick walls for building works and one part of cement to 5 parts of sand for other works, and sufficient water to produce the 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.

7.5.2 **Mortar for fair face Brick Cladding (gutka)**

The mortar for all fair face brick (gutka) masonry cladding shall consists of cement, surkhi and sufficient water to produce proper consistency in the following composition:

Cement	:	Surkhi
1	:	4

OR

Swan pozzolana in the ratio as recommended by the manufacturer.

7.5.3 **Mortar Batching**

Methods and equipment used for mixing mortar shall 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. If a mixer is used, it shall be of approved design and the mixing time after all the ingredients are in the mixer, except for the full amount of water, shall not be less than two minutes. Mortar shall be mixed only in sufficient quantities for immediate use and all mortar not used within 30 minutes after addition of the water to the mix shall be wasted. Retempering of mortar will not be allowed. Mixing troughs pans shall be thoroughly cleaned and washed at the end of each day's work.

8. BRICKS

8.1 **Brick Materials**

Bricks for plain brick masonry shall be first class bricks made from carefully selected earth which shall be good loam or clay. The earth shall be free from objectionable quantities of lime, gravel, coarse sand and roots and other organic matter. The salt contents shall not exceed 0.3 per cent and calcium carbonate content shall not exceed 2 per cent.

8.2 **Brick Manufacture**

All bricks shall be manufactured by the Trench Kiln Method or other standard method approved by the Engineer. The moulds to be 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. Each finished brick shall be a nominal 230x115x75 mm in size, shall weigh between 3.2 and 4.1 kilograms and shall have a "frog" 6 millimetre deep on the upper face. The bricks shall be thoroughly burnt but without being vitrified. The bricks used shall be well burnt, uniform in shape, size, texture, Color and should produce a ringing sound when struck. The bricks shall be free from flaws, cracks, chips, stone nodules of lime or kankar or other blemishes. Bricks over burnt, vitrified, irregular in shape or not having uniform Color or under burnt shall not be used. Bricks of uniform size shall be used throughout the work and the source of supply shall not be diversified.

8.3 **Stacking And Sampling**

The bricks shall be sorted and arranged 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 2 feet (0.6 metres) space between the stacks shall be left for the purpose of inspection. Each size or class of brick shall be stacked separately. For purposes of inspection and tests the sample bricks shall be selected by the Engineer or a person authorized by the Engineer for this purpose. These samples shall be furnished by the Contractor without charge. The sampling shall conform to ASTM C 67. For the modulus or rupture, compressive strength and absorption determinations at least 10 bricks shall be selected from each lot of 25,000 bricks or a fraction thereof. For larger lots five additional bricks shall be selected from each 50,000 bricks or a fraction thereof contained in the lot. In no case shall less than 5 bricks be taken.

Additional specimens may be taken at the discretion of the Engineer. Each specimen shall be marked so that it may be identified at any time. Markings shall not cover more than 5 per cent of the superficial area of the specimen.

9 SCAFFOLDING

Contractor shall provide safe scaffolding of adequate strength for use of workmen at all levels and heights. Scaffolding which in the opinion of the Engineer is unsafe, shall not be used until it has been strengthened and made safe for use of workmen to the satisfaction of the Engineer.

Damage to masonry from scaffolding or from any other causes shall be repaired by the Contractor.

10 EXECUTION

10.1 **PLACING BRICK MASONRY**

The methods and equipment used for transporting the bricks and mortar shall be such as will not damage the brick nor delay the use of mixed mortar. Brick shall not be placed during rains sufficiently heavy or prolonged to wash the mortar from the brick. Mortar already spread which becomes diluted by rain shall be removed and replaced before continuing with the work. All brick to

be used in brick masonry shall be moistened with water for three to four hours before they are used by a method which will ensure that each brick is thoroughly and uniformly wetted. All bricks shall be free from water adhering to their surface when they are placed in the brick masonry.

Bricks shall be laid "frog" upward with mortar joints and in English/Flemish bond as shown on the Drawings or as directed by the Engineer. Both bed and vertical joints shall be approximately 6mm and 10mm 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 repointed.

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

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

The fair face Brick cladding (gutka) shall be laid in running bond unless otherwise as shown on the drawing or directed by the Engineer.

10.2 **CURING**

All brickwork requiring mortar shall be cured by water or other acceptable methods. All methods and operations of the Contractor in curing the different portions of the work shall be subject to the approval of the Engineer. When curing by water, the brickwork shall be kept wet for 7 days unless specified otherwise or covered with water-saturated material or by a system of perforated pipes, mechanical sprinklers, porous hose, ponding or by any other approved method which will keep all surfaces to be cured continuously wet. Water used for curing shall meet the requirements for water used in the manufacture of bricks.

10.3 **Finishing**

All bricks shall be skillfully laid frog face up with level courses, uniform joints, square corners, plumb verticals and true surfaces, except when otherwise shown on Drawings or directed by the Engineer. Where the brickwork is required to be covered by mortar coating, the required finish shall be as indicated on the Drawings and shall meet with the requirements of the relevant specifications.

10.4 **Cement Mortar Coating**

Brickwork surfaces which are intended to receive paint coatings, shall have an overcoating of cement mortar. The mortar shall consist of one part Portland cement to four parts of sand by volume and sufficient water to produce the proper consistency for the intended use. The surface on which mortar is to be applied shall be rough, clean and damp. The first layer of mortar, about 6 mm thick shall be forcibly dashed onto the surface so as to bond more tightly. The full thickness of the cement coating shall be ½" (12mm) except where otherwise shown on the Drawings or directed by the Engineer.

10.5 **Pointing**

Brickwork surfaces which are intended to receive pointing shall be given V-notch pointing by striking the joints. Tooling shall be done when the mortar is partially set but still sufficiently plastic to bond. All tooling shall be done with a tool which compacts the mortar. Raked joints shall be ½" (12mm) deep V-notch, 70 degree apex in order to give pressed and compacted surface. All joints shall be given finish with 1:3 cement sand mortar with a pointing tool.

11 REPAIRING BRICKWORK

11.1 If, after the completion of any brickwork, brick is out of alignment or not level, or does not conform to the lines and grades 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 the defective area.

11.2 At the completion of the work, all holes and defective mortar joints shall be cut and repointed. Exposed masonry shall be protected against staining or other damages and excess mortar shall be cleared off the surfaces as the work progresses. All exposed masonry shall be clean, smooth, plumb and shall be of acceptable finish. In the event ordinary cleaning is not adequate, special methods such as sand blasting or otherwise as approved by the Engineer, shall be used to clean the surfaces.

12 HORIZONTAL DAMP PROOF COURSE

All Horizontal damp proof courses unless otherwise specified in the drawings shall consists of class 'B' cement concrete (3000 psi) 2" (50mm) thick, mixed with 2.5 kg of pudlo/bag of cement or other approved quality water proofing compound 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, levelled and edges corners made to the requirements of the relevant drawings including finishing and curing complete. Including two float coat of hot bitumen 10/20 penetration grade shall be applied over the class "B" cement concrete @ 7 kg/100 sft.

13 VERTICAL DAMP PROOF COURSE

All vertical damp proof courses unless otherwise specified in the drawings shall consists of ½" thick cement sand plaster in 1:3, mixed with 2.5 kg of pudlo/bag of cement or other approved quality water proofing compound as per manufacturer's specifications and shall be applied at required elevation as per drawings and instructions by the Engineer, including two float of hot bitumen 10/20 penetration grade shall be applied over plaster @ 7kg/100sft..

14 MEASUREMENT AND PAYMENT

14.1 **General**

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

14.2.1 Cutting & chiselling of masonry wherever required.

14.2.2 Cement sand mortar used in laying bricks including wastage.

14.2.3 Curing and repairing the masonry work.

14.2.4 All joint reinforcing bars, reinforcing anchor bars or hoop iron

14.2.5 Horizontal Damp proof course of class “B" concrete (3000 psi) including damp proof materials.

14.2.6 Vertical Damp proof course of 1:3 Plaster including damp proof materials

14.2.7 Scaffolding for Masonry Work.

14.2.8 2-1/2” long steel nails to be fixed in Brick masonry after every 5th cousrs at a distance 6” c/c for fair face Brick Cladding.

14.2.9 Cement sand mortar in 1:4 at the back of the fair face brick (Gutka) cladding to make it in plumb if required.

14.3 Brick Masonry

14.3.1 Measurement

In case of different thickness of slab in different areas or room or for any other reason whatsoever, if chiseling of masonry is required, the Contractor shall do so at his own cost where, for any reason whatsoever, the height, of the wall is short of ceiling height, of the actual height shall be made good with 3000 psi nominal mix concrete. This concrete shall neither be measured nor be paid under item of concrete but will be paid for under item of wall masonry. Similarly where the lintel heights are such that the Contractor has to chisel the masonry or provide cast-in-place concrete to make up the height of the course, no payment will be made for chiseling, but where such cast- in-place concrete is provided, payment for the same will be made at the unit rate for masonry. Measurement of acceptably completed works of brick masonry will be made on the basis of number of cubic feet for 9” (230mm) thick and above and for 4-1/2” (115mm) thick and below in Sq. feet as provided & installed in position as shown on the Drawing or as directed by the Engineer. All opening more than 1 Sq. ft (0.1 Sq. metre) area left in the masonry wall shall be deducted.

14.3.2 Payment

Payment will be made for acceptable measured quantity of brick masonry on the basis of unit rate per cubic foot for 9” (230mm) thick and above and 4-1/2” (115mm) thick and below in square foot quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

14.4 Fair Face Brick Cladding in Cement Surkhi

14.4.1 Measurement

Measurement of acceptably completed works of fair face brick cladding will be made on the basis of actual area in Square feet of wall laid in position to the line, level as shown on the Drawing or as directed by the Engineer.

14.4.2 Payment

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

PLAIN AND REINFORCED CONCRETE

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 connection with the supply and installation of plain and reinforced concrete work complete, in 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.

2 GENERAL

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

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

2.3 Shop drawings shall be prepared by the Contractor at his own cost. Approval of shop drawings as well as that of actual samples of concrete finish shall be obtained before work is commenced.

3 CODES AND STANDARDS

The work shall conform to the requirements of the following latest Codes and Standards, unless otherwise specified.

ACI 301-latest	Specifications for structural concrete for buildings.
ACI 304-latest	Guide measuring, mixing, transporting and placing concrete.
ACI 308-latest	Standard practice for curing concrete.
ACI 309-latest	Guide for consolidation of concrete.
ACI 325.9R	Guide for construction of concrete pavements and concrete bases.
ACI 318-latest	Building code requirements for structural concrete.
ASTM C 31-latest	Practice for making and curing concrete test specimens in the field.
ASTM C 33-latest	Standard specifications for concrete aggregates.
ASTM C 39-latest	Standard test methods for compressive strength of cylindrical concrete specimens.
ASTM C 42-latest	Standard test, method for obtaining and testing drilled cores and sawed beams of concrete.
ASTM C 78-latest	Standard test method for flexural strength of concrete (using simple beam with third point loading).
ASTM C 136-latest	Standard test method for sieve analysis of fine and coarse aggregates.
ASTM C 143-latest	Standard test method for slump of Portland cement concrete.
ASTM C 150-latest	Standard specifications for Portland cement.
ASTM C 260-latest	Standard specifications for air-entraining admixtures for concrete.

ASTM C 309-latest	Specification for liquid membrane-forming compounds for curing concrete
ASTM C 404-latest	Standard specifications for aggregate for masonry grout.
ASTM C 494-latest	Standard specifications for chemical admixtures for concrete.
ASTM C 566-latest	Standard test method for total moisture content of aggregate by drying.
ASTM C 869-latest	Standard specifications for foaming agents used in making preformed foam for cellular concrete.
ASTM D 596-latest	Reporting results of water analysis.
ASTM D 1190-latest	Standard specifications for concrete joint sealer, hot-poured elastic type.
ASTM D 1751-latest	Standard specifications for preformed expansion joint filler for concrete paving and structural construction (non-extruding and resilient bituminous types).
ASTM D 1752-latest	Preformed sponge rubber and cork expansion joint fillers for concrete paving and structural construction.
BS 12-latest	Specifications for ordinary and rapid hardening Portland cement.
BS 3148-latest	Methods of tests for water for making concrete.
PS 232-latest	Portland cement (ordinary, rapid hardening and high strength)
PS 243-latest	Concrete coarse and fine aggregates from natural sour.
PS 279-latest	Abrasion of coarse aggregates by the use of Los Angeles machines.
PS 280-latest	Method of test for determination of aggregates crushing value
PS 281-latest	Method of test for organic impurities in sand for concrete aggregates.
PS 283-latest	Method of test for soundness of aggregates by the use of sodium sulphate or magnesium sulphate.
PS 284-latest	Sampling aggregates for concrete
PS 285-latest	Method of test for sieve or screen analysis of fine and coarse aggregates
PS 286-latest	Description and classification of mineral aggregates
PS 421-latest	Sampling of fresh concrete
PS 560-latest	Making and curing concrete compression test specimen in the field
PS 612-latest	Sulphate resisting Portland cement type 'A'
PS 716-latest	Mixing and sampling of fresh concrete in the laboratory
PS 717-latest	Test for concrete compacting factor
PS 849-latest	Making and curing concrete compression test cubes
PS 1638-latest	Fresh concrete, determination of consistency slump test.

4. SUBMITTALS

4.1 Delivery and Storage Record

The Contractor shall submit the following to the Engineer in such form as he may require:

- Accurate records of deliveries of cement and its use in the Works.
- Details of transport, plant, equipment for winning, transporting, manufacturing of aggregate.
- Manufacturer's literature and certification for compliance with the requirements for admixtures and other materials required for concrete work.

4.2 Details of Constructional Plants

Particulars and details of major constructional plants such as mixers, lifts, hoists and cranes, alongwith the general layout plans and flow diagrams for the Engineer's review and prior approval.

4.3 Shop Drawings

Shop drawings including, but not limited to lifts in concrete, formwork, jacking, shoring, architectural concrete works etc., as required by the Engineer.

4.4 Methodology

Methodology for construction alongwith the scheduled programme of works and the Contractor's proposed arrangements for batching, mixing, conveying, placing and curing for review and approval by the Engineer.

The method statement shall also include proposals for:

- Construction joints if not shown on the Drawings
- Installation of water stops
- Sequence of concrete placement
- Arrangement for concreting during rain, hot or cold weather and during night
- Transportation, handling and erection and/or installation of precast concrete and/or prefabricated units etc.
- Welding, etc.

4.5 Samples and Specimens

The Contractor shall submit to the Engineer for his approval:

- Samples and specimens of all constructional materials together with the supplier/manufacturer's literature containing his instructions/ recommendations. Afterwards the approved samples of aggregate, admixtures and the embedded items shall be submitted properly labelled and identified for future reference.
- Samples of precast concrete units for inspection, testing and for the Engineer's review and approval.
- A minimum of two units or portions of units of each of the architectural and In-situ concrete, of a size as required by the Engineer, shall be submitted. These specimens will be reviewed and approved on the basis of Color, texture, dimensional accuracy, surface finish and general appearance.
- Samples/specimens, when accepted, will describe the allowable limits between which variation can be acceptable.
- Approved specimen/samples shall remain at Site, well protected from damage and dilapidation, as required by the Engineer.

4.6 Certificates and Mill-Test-Data

Manufacturer's or supplier's certificate of compliance with relevant standards/specifications shall be submitted for each consignment of the materials and items supplied for use in the Works including but not limited to the following:

Cement, reinforcing steel, admixtures, joint sealing compound, expansion joint material, water-proof membrane, PVC water stop and aggregates etc.

Calibration certificates in respect of scales, gauges, metres and other weighing and dispensing devices to be used on batchers and mixers shall be submitted for the first time immediately before their use in producing concrete and thereafter at every 6 week intervals or earlier if so directed by the Engineer.

4.7 Results of Routine Tests and Daily Reports

The routine shall include submission of the results of all the specified and required tests performed at the job site including, but not limited to, analysis of aggregate, slump test, compressive strength tests, etc., and detailed report of works performed on the preceding day.

4.8 Bar-Bending Schedule

Bar bending schedule shall be submitted for the Engineer's review and approval well in advance of cutting and bending of any reinforcing steel. This shall include corrections for elongations during bending.

4.9 Concreting Record

Daily returns of all concrete placed during the previous day shall be submitted in a format to be agreed with the Engineer.

The returns shall include but shall not be limited, to the following information:

For each specified grade and type of concrete

- Volume of concrete placed per batch and the total concrete.
- Volume of concrete wasted or rejected.
- Quantities of cement, aggregates, water, reinforcing steel, admixtures, embedded items used in the work.
- For each location, structure or part of structure
- The precise position or location of placement, (e.g. reference number, mark identification or element, structure, bay or lift).
- Concrete mixes placed.
- Total volume of each grade and type of concrete placed.
- Records of concrete works, detailing the date, time, humidity, temperature and weather conditions when each part of works was completed.

5. TOLERANCES

The Contractor is to complete all works including formwork, placement, curing, etc, and shall ensure that the concrete surfaces conform to the specified tolerance limits given in ACI 325.9R and 347. Where tolerances are not stated on the Drawings, maximum permissible deviations from established lines, grades and dimensions shall conform to the tolerances given hereinafter.

These tolerances are not cumulative.

Concrete work not meeting the tolerance requirements will be rejected unless an acceptable repair work is allowed by the Engineer.

5.1 Cast in Place Concrete

VARIATION FROM PLUMB: Variation from plumb in vertical lines and surfaces and from the batter in inclined lines and surfaces shall not exceed the limits given in the Table-A

Table-A

Columns,piers,walls and arrises		**Exposed corner columns, control joint grooves and other conspicuous lines**	
In any 10 ft length or height	¼ inch	In any bay or 20 ft length or height	3/8 inch
In any storey or 20 ft height	3/8 inch	Maximum for the entire length or height	½ inch
Maximum for the entire length	1 inch		

VARIATION FROM LEVEL OR GRADES: Variation from the Specified level and grades shall not exceed the limits given in Table-B.

Table-B

Columns,piers,walls and arrises		**Exposed corner columns, control joint grooves and other conspicuous lines**	
In any 10 ft length or height	¼ inch	In any bay or 20 ft length	¼ inch
In any bay or 20 ft height	½ inch	Maximum for the entire length	½ inch
Maximum for the entire length	¾ inch		

VARIATION FROM POSITION IN PLAN: Variation of the linear building lines from established position in plan and related position of columns, walls and partitions shall not exceed ½ inch any bay of 20 ft nor a maximum of 1 inch in the entire length.

VARIATION IN LOCATION OF OPENINGS: Variation in the sizes and locations of sleeves, floor openings, and wall openings shall not exceed a maximum of ½ inch.

VARIATION IN DIMENSIONS: Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls shall not exceed minus 1 inch nor plus ½ inch

VARIATION IN FOOTINGS: Variation in footings shall not exceed the limits given in Table-C

Table-C

Dimension in Plan	**Misplacement or eccentricity**	**Thickness**
Minus ½ inch Plus 2 inch	2% of footing width in the direction of misplacement but not more than 2 inch.	decrease 5% increase No limit

(Tolerances apply to concrete dimensions only, not to positioning of vertical reinforcing steel, dowels, or embedded items.)

VARIATION IN STEPS: Variation in consecutive steps shall not be more than 1/16 inch in rise and 1/8 inch in tread. The maximum variation in the flight of stairs shall not be more than 1/8 inch in rise and ¼ inch in treads.

5.2 Precast Concrete

Forms must be true to size and dimensions of concrete members shown on the plans and shall be so constructed that the variation in the dimensions of the finished products, at the time of placement of these units in the structure, will be within the limits shown in Table-D unless otherwise noted on structural/architectural Drawings:

Table-D

– **Variation in Overall dimensions of members**	**per 3 ft**	**1/16 inch**
– Variation in Cross-sectional dimensions:		1/16 inch
* sections less than 3 inches		1/8 inch
* sections over 3 inches and less than 18 inches		¼ inch
* sections over 18 inches		
– Deviations from straight line in long sections	Not more than per 10 ft.	1/8 inch
– Deviation from specified camber	10 ft of span	1/16 inch
– Maximum differential between adjacent units in erected position		¼ inch

5.3 Pavements

Departure from specified lines, levels and grades shall not exceed the following limits:

– Established alignment	¼ inch
– Eestablished longitudinal grade on any line	½ inch
– Transverse template contour except at transverse joints	1/8 inch
– Transverse template contour at transverse joints in width of one traffic lane	¼ inch

6. QUALITY ASSURANCE

6.1 Cement

Cement shall be stored and sampled at Site and tested from time to time at the discretion of the Engineer in accordance with ASTM C-150 or its equivalent British or Pakistan Standards at the expense of the Contractor. If the tests prove that the cement has become unsatisfactory, it shall be removed from the Site immediately. Cement which has been in storage at the Site longer than three months, shall not be used until retesting proves it to be satisfactory.

6.2 Aggregate - Requirements

Aggregates shall conform to ASTM C-33. Following tests shall be carried out by the Contractor at his own cost to establish suitability of the material for the intended use.

- Mechanical properties
- Porosity
- Organic impurities
- Clay and Silt Contents
- Abrasion and Soundness tests
- Alkali Re-activity Potential
- Water soluble chloride contents

6.3 Sampling and Testing of Aggregate

During construction, aggregates shall be sampled and tested once for every 100 tonnes or part thereof as delivered to the mixer to determine compliance with the Specifications. The Contractor shall provide samples and test such samples in the presence and supervision of the Engineer using appropriate standard test methods selected by the Engineer. Testing of concrete aggregates by the Engineer shall not relieve the Contractor of his responsibility to maintain control and to ensure the production, stockpiling and handling of both fine and coarse aggregates in accordance with these Specifications. Tests shall be carried out only in laboratories approved by the Engineer.

6.4 Deleterious Substances

FINE AGGREGATE: The maximum percentages of deleterious substances in the fine aggregate as delivered to the mixer shall not exceed the values given in Table-E

Table-E

Item	Max.percent (by weight)
Material finer than 75 um (No. 200) sieve	3
Shale	1
Total of other deleterious substances (such as mica,chlorides, coated grains and soft flaky particles)	3

The sum of the percentages of all deleterious substances shall not exceed 5 per cent by weight.

COARSE AGGREGATE: The maximum percentages of deleterious substances in any size of coarse aggregate, as delivered to the mixer, shall not exceed the values given in Table-F

Table-F

Substances	Maximum percent by weight
Material passing 75 um (No.200) sieve	1
Shale	1
Clay lumps	1/2
Other deleterious substances	1

The sum of the percentages of all deleterious substances in any size, as delivered to the mixer, shall not exceed 3 per cent by weight.

6.5 Moisture Control

All fine aggregate and smallest size group of the coarse aggregate shall remain dry during storage at the Site for at least 72 hours immediately prior to use. The free moisture content of the fine aggregate and of the smallest size group of coarse aggregate, as delivered to the mixer, shall be controlled so as not to exceed 4% and 1% respectively, by weight of the saturated surface dry aggregates unless higher limits are allowed by the Engineer. The moisture content of the other size of the coarse aggregates shall be controlled so that the aggregates are delivered to the mixers with the least amount of free moisture and the least variation in free moisture practicable under the job conditions. The moisture content of the aggregate shall be determined in accordance with ASTM C-566. In addition to the limits on the maximum amounts of free moisture in aggregates, the moisture content shall be controlled so that for each size the variation in the percent of free moisture will not be more than 0.5 percent during any one hour of mixing plant operation and not more than 2.0 percent during any 8 hour period of mixing plant operation. Under no conditions shall the aggregate be delivered to the mixing plant dripping wet.

The Contractor may accomplish the required moisture control by use of freely-drained storage, covered transportation and storage, mechanical dewatering devices or any other means or combination of means acceptable to the Engineer.

6.6 Admixtures

No admixtures shall be used without the approval of the Engineer for which the following procedure shall be followed:

- 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.

6.7 Testing Facilities

The Contractor shall make arrangement for testing of cylinders to be fixed by the Engineer from time to time shall be tested from an approved laboratory.

Concrete strength shall be determined on the basis of test cylinders, however with the approval of the Engineer compressive strength may also be controlled on the basis of test cubes. The cube strength in such case shall be multiplied by a relevant factor shown in Table-M or as agreed by the Engineer to arrive at the cylinder strength.

7. CONCRETE MIX DESIGN

Concrete shall be composed of Portland cement, fine and coarse aggregate, water and any admixtures as specified.

The concrete mixes for each grade of concrete shall be designed by the Contractor under the supervision of the Engineer. The proportions of concrete components for each grade of concrete once agreed by the Engineer would be changed only with the approval of the Engineer or as directed by him during progress of the Work.

8. INSPECTION AND TESTING

8.1 Inspection

Concrete batching, mixing, delivery and all other construction work shall be inspected at intervals decided by the Engineer to ensure compliance of all operations with Specifications and other provisions of the Contract.

No concrete shall be placed until all forms and all items to be embedded in concrete are inspected and approved by the Engineer in writing.

Completed concrete work which fails to meet one or more of the requirements of the Specifications and/or other Contract documents shall either be rejected or repaired to the Engineer's satisfaction.

8.2 Testing of Concrete

All tests shall be carried out at laboratories approved by the Engineer. The Engineer's Representative shall be present during testing if so required by the Engineer.

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. In general three set of three cylinders 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.

Cylinder 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.

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: 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. 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. 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 Contractor's fault or negligence, the entire cost of replacing faulty concrete or carrying out prescribed corrective measures shall be borne by the Contractor who shall also reimburse the Employer for the cost of making tests. Otherwise, payment for removing and replacing faulty concrete or carrying out prescribed corrective measures will be made under applicable Items of the Bill of Quantities as determined by the Engineer.

RELATION BETWEEN ALLOWABLE STRENGTH AND CONTROL TEST CYLINDER STRENGTH: Where cylinders are made by wet screening of concrete with aggregate greater than 1-1/2 inch size, such as 3 inch aggregate concrete, the cylinders will be required to have a compressive test strength greater than the allowable strength shown on the Drawings, to indicate that the respective concrete in place in the work has the allowable strength shown. The mix design shall be such that the average strength of the specimens tested is greater than the allowable strength shown on the Drawings for the (3 inch aggregate) concrete. Such increments over the allowable strength shown will be established by the Engineer after the mix design has been done and prior to mixing of concrete, and shall be approximately ten per cent.

9. DELIVERY AND STORAGE

9.1 Transportation of Cement

Transoration of the cement from the factory to the Site stores and to the point of use shall be accomplished in such a manner that the cement is completely protected from exposure to moisture. Cement which has been adversely affected by moisture, as determined by the Engineer, shall be rejected. Cement in sacks shall be delivered in strong, well made sacks, each plainly marked with the manufacturer's name, brand, type of cement and the weight of cement continued therein. Packages varying from the standard weight marked thereon may be rejected and if the average weight of packages in any consignment as shown by weighing fifty packages taken at random, is less than that marked on the packages, the entire consignment may be rejected. Packages received in broken or damaged condition shall be rejected or may be accepted only as fractional packages as determined by the Engineer.

9.2 Storage of Cement

Cement shall be stored at Site in dry, weather tight and properly ventilated stores. All storage facilities shall be subject to approval and shall be such as to permit easy access for inspection and identification of each consignment. Adequate storage capacity shall be furnished to provide sufficient cement to meet the peak needs of the project.

The Contractor shall use cement in the approximate chronological order in which it is received at the Site.

Cement storage facilities shall be emptied and cleaned by the Contractor when so directed.

Suitable, accurate scales shall be provided by the Contractor to weight the cement in stores and elsewhere on the Site, if required, and he shall also furnish all necessary test weights.

9.3 Storage of Aggregates

Aggregate shall be stored at the Site in such a manner as to prevent its contamination. Aggregate which has deteriorated or which has been contaminated shall not be used for concrete. All methods employed by the Contractor for loading, unloading, handling and stockpiling aggregates shall be subject to the approval of the Engineer. Sufficient quantities of aggregate shall be maintained at the Site at all times to assure continuous placement and completion of any lift of concrete started.

10. MATERIALS

10.1 CEMENT

10.1.1 General

Cement shall be fresh, furnished in sacks as approved by the Engineer. Unless otherwise permitted, cement from not more than two plants shall be used and in general, the product of only one plant shall be used in any particular section of the work. Cement recovered through cleaning of sacks shall not be used.

10.1.2 Portland Cement

Portland cement shall be of Pakistan origin and manufacture unless otherwise approved by the Engineer. Portland cement shall conform to Pakistan Standard PS-232 or to British Standard BS-12 or to ASTM C 150 type-I. Portland cement conforming to ASTM C-150, Rapid hardening type-III or sulphate resistant type-V may also be used in certain parts of the Works as directed by the Engineer.

10.2 AGGREGATES

10.2.1 Requirements

The nominal maximum size of the aggregates shall not be larger than one fifth of the narrowest dimension of the finished wall or slab, or larger than three fourth of the minimum clear spacing between the reinforcing steel and embedment. These limitations may be waived if, in the judgment of the Engineer, workability and method of consolidation be such that the concrete can be placed without honey-combs or voids.

10.2.2 Composition

The use of natural sand or a combination of natural and manufactured sand may be permitted, provided that the fine aggregate meets the applicable requirements of the Specifications for the particular use intended. Coarse aggregate shall consist of gravel, crushed stone or a combination thereof.

10.2.3 Source

The Contractor shall obtain concrete aggregate from deposits of natural sand and gravel or shall procure crushed aggregate from approved quarries which produce aggregates meeting with the Specifications contained herein.

10.2.4 Processed Aggregates

The Contractor in procuring the processed aggregates or in planning his aggregate processing operations shall ensure that the aggregates, as delivered to the mixer, consist of clean, hard and uncoated particles; light weight elements (chalk, clay, coal) are separated by segregation under water by vibration where required and the fines are removed from the coarse aggregate by adequate washing. The coarse aggregate shall be rescreened just prior to delivery to the concrete mixer bins. The moisture content shall conform to the provisions of sub-section 6.5 "Moisture Control". Compliance with the aggregate grading and uniformity requirements shall be determined before the material is delivered at the mixer. All aggregates shall be sieved and washed with clean water. The aggregates shall conform to the specific requirements given hereinafter.

10.2.5 Fine Aggregate

The grading of fine aggregate as delivered to the mixers shall conform to the requirements given in Table-G

Table-G

ɛve size Standard square mesh	***rcentage passing (by weight)***
3/8 inch	100
No. 4	95 to 100
No. 8	80 to 100
No. 16	50 to 85
No. 30	25 to 60
No. 50	10 to 30
No.100	2 to 10

Te Fineness Modulus shall range between 2.31 and 2.51

10.2.6 Coarse Aggregate

The grading of the coarse aggregate as delivered to the mixer shall conform to the requirements given in Table-H

TABLE-H Grading Requirements for Coarse Aggregate

		Amounts Finer than Each Laboratory Sieve (Square openings) Weight Percentage												
	Nominal Size (Sieves with Square Openings)	4”	3½”	3”	2½”	2”	1½”	1”	¾”	½”	3/8”	No.4	No.8	No.100
	3½” to 1½”	100	90 to 100	------	25 to 60	------	0 to 15	------	0 to 5	------	------	------	------	------
	2½” to 1½”	------	------	100	90 to 100	35 to 70	0 to 15	------	0 to 5	------	------	------	------	------
	2” to 1”	------	------	------	100	90 to 100	35 to 70	0 to 15	------	0 to 5	------	------	------	------
	2” to No.4.	------	------	------	100	95 to 100	------	35 to 70	------	10 to 30	------	0 to 5	------	------
	1½” to ¾”	------	------	------	------	100	90 to 100	20 to 55	0 to 15	------	0 to 5	-----	------	------
	1½” to ¾”	------	------	------	------	100	95 to 100	------	35 to 70	------	10 to 30	0 to 5	------	------
	1” to ½”	------	------	------	------	------	100	90 to 100	20 to 55	0 to 10	0 to 5	-----	------	------
	1” to ¾”	------	------	------	------	------	100	90 to 100	40 to 85	10 to 40	0 to 15	0 to 5	------	------
	1” to No.4.	------	------	------	------	------	100	95 to 100	------	25 to 60	-----	0 to 10	0 to 5	------
	¾” to 3/8”	------	------	------	------	------	------	100	90 to 100	20 to 55	0 to 15	0 to 5	-----	------
	¾” to No.4.	------	------	------	------	------	------	100	90 to 100	-----	20 to 55	0 to 10	0 to 5	------
	½” to No.4.	------	------	------	------	------	------	------	100	90 to 100	40 to 70	0 to 15	0 to 5	------
	3/8” to No.8.	------	------	------	------	------	------	------	-----	100	85 to 100	0 to 30	0 to 10	0 to 5

10.2.7 Particle Shape

The shape of the particles in fine and coarse aggregate shall generally be spherical or cubical. The quantity of flat and elongated particles in the separated size groups of coarse aggregate, as defined and determined by standard tests approved by the Engineer, shall not exceed 15 per cent by weight in any size group. A flat particle is one having a ratio of width to thickness greater than three. An elongated particle is one having a ratio of length to width greater than three.

10.2.8 Soft Particles

The Contractor in procuring processed aggregates or in planning his aggregate processing operations shall make whatever provisions are necessary, as regards methods and equipment, to ensure effective elimination of soft particles from all aggregates to the degree that the percentage of soft particles present in the processed coarse aggregate does not exceed 3 per cent by weight when determined in accordance with the applicable requirements of ASTM C-851, or other standard test methods selected by the Engineer. Test samples shall be representative of each size group of processed aggregate specified in Table-H, obtained according to ASTM C-851. Weight of samples for each size group shall be as given in Table-I

Table-I

Size No.	Nominal Size	Weight of Sample in Kilograms
8.	3/8" to No.8	0.6
7.	1/2" to No.4	1.0
6.	3/4" to 3/8"	1.5
5.	1" to 1/2"	3.0
4.	1-1/2" to 1"	4.5
3.	2" to 1"	7.0
2.	2-1/2” to 1-1/2”	16.0

10.3 WATER

Water for washing aggregates and for mixing and curing concrete shall be fresh, clean and free from injurious amounts of oil, acid, alkali, salt, organic matter, or other deleterious substances as determined by ASTM D-596.

The water for curing concrete should have a pH value between 6 to 8 and shall not contain impurities which cause discoloration of concrete.

10.4 ADMIXTURES

10.4.1 Approval Required

Admixtures, including air-entraining admixtures, foaming chemicals and water-reducing admixtures, shall not be used, except with the prior approval of the Engineer. All tests for the evaluation and approval of an admixture shall be made by the Contractor as specified in sub-section 6.6 of these Specifications.

10.4.2 Air-Entraining Admixtures

The source and brand of air-entraining admixture, if required, shall be proposed by the Contractor and approved by the Engineer. The air-entraining admixture will be an approved substance or compound conforming to the requirements of ASTM C-260, which will produce entrained air in the concrete as hereinafter specified. The air-entraining admixture shall be added to the batch in solution in a portion of the mixing water. This solution shall be batched by means of a mechanical batcher capable of accurate measurement and in such a manner as to ensure uniform distribution of the admixture throughout the batch during the specified mixing period.

10.4.3 Water-Reducing Admixtures

The source, brand, types of suitable water reducing cement dispersing admixtures, if required, shall be proposed by the Contractor and approved by the Engineer. The water-entraining admixture will be compatible with the air-entraining admixture specified above and shall be batched and added to the concrete in the manner specified for the adding of air-entraining admixture but separate from the portion of the mixing water containing the air-entraining admixture. The quantities of water-reducing, cement-dispersing admixture to be used shall be in accordance with the instructions of the manufacturers as approved by the Engineer. Water reducing admixture shall conform to the requirements of ASTM C-494.

10.5 WATERSTOPS

10.5.1 PVC Waterstops

PVC (Polyvinylchloride) waterstops shall be extruded from an elastomeric plastic compound, the basic resin of which shall be polyvinylchloride. The compound shall contain such additional resins, plasticizers, stabilizers or other materials needed to ensure that when the material is compounded and extruded to the shapes and dimensions shown and tested it shall have the physical characteristics when tested by the U.S Corps. Of Engineer test method as shown in Table-J.

Table-J

Corps of Engrs.Tests Method No.	No. of Specimens Tested	Physical characteristics	Requirement
1	2	3	4
568	5	Tensile strength using die III, not less than	1750 psi

573	5	Ultimate elongation using die III, not less than	350%
570	3	Low temperature brittleness, no sign of failure such as cracking or chipping at	-37º C
571	3	Stiffness in flexure 1/2 inch span, not less than	400 psi

10.6 JOINT SEALING COMPOUND

Sealing compound shall be either of the cold application type conforming to ASTM D-1850 or of the single or multiple component type or of the hot poured type conforming to the requirements of ASTM D-1190 or their equivalents.

10.7 EXPANSION JOINT FILLER

Expansion Joint filler material shall be premoulded asphalt impregnated fiber board, to be applied over the full joint-width, except as otherwise indicated on the Drawings, and shall conform to ASTM D-1751 where non-extruding and resilient bituminous type is indicated but where non-extruding and resilient non-bituminous is required the expansion joint filler shall consist of sponge rubber, self-expanding cork or any other material and type as directed by the Engineer, meeting the requirements of ASTM D-1752.

10.8 NON-SHRINK GROUT

Non-shrink grout of a thickness less than one inch shall consist of one part cement, one part clean sharp sand and 1:22000 to 1:15000 part of grained aluminum powder containing non-polishing agent. Non-shrink grout one inch or more in thickness shall be proportioned as above except that 1.5 parts of 3/8 inch to ¼ inch (pea-size) gravel shall be added to the mix. The above composition may be varied if so required by the Engineer. In each case, however, the Contractor shall, at his own cost, prepare optimum mix design and conduct testing of the grout composition for strength and non- shrink performance. Pre-mix non-shrink grout from approved manufacturers my also be used as required by the Engineer.

10.9 EPOXY CONCRETE AND MORTAR

10.9.1 General

Epoxy concrete for installation adjacent to embedded metal and epoxy concrete and/or mortar for the replacement of faulty concrete or for other special purposes as ordered or approved by the Engineer shall conform to the requirements specified hereunder. Epoxy concrete and epoxy mortar shall be mixed in the proportions by such methods and with such equipment as are recommended by the manufacturer of the epoxy resin and approved by the Engineer. The proportions of epoxy mortar and epoxy concrete and the methods of mixing and placing will be subject to change to meet field requirements. The individual batch size of epoxy concrete and mortar which may be prepared at one time

shall not exceed the amount that may be mixed, placed and finished in accordance with the manufacturer's instructions as approved by the Engineer.

10.9.2 Materials

EPOXY RESIN: Epoxy resin shall be subject to approval by the Engineer.

AGGREGATES FOR EPOXY CONCRETE: The aggregates used for epoxy concrete shall be clean, dry, crushed river cobble gravel ¾ inch maximum size. Except for gradation, fine and coarse aggregates shall meet the requirements of ASTM C-33. Gradation of fine aggregate shall be the same as specified in sub-section 10.2.5, except that the percentage passing a No. 100 sieve shall be held to the lower limit specified to the greatest extent practicable. The fine and coarse aggregates used in preparation of epoxy resin concrete shall be oven dry and shall be conditioned to a temperature of 15^{O}C to 21^{O}C prior to mixing the epoxy resin binder. Gradation of the coarse aggregate shall conform to the requirements of Table-K when tested in accordance with ASTM C-136.

Table-K

Sieve Size Standard Sq. Mesh	**Per cent passing (by weight)**
3/4 inch	100
1/2 inch	90 - 100
3/8 inch	40 - 70
No.4	0 - 15
No.8	0 - 5

The aggregates shall be well graded from coarse to fine.

AGGREGATES FOR EPOXY MORTAR: Except for gradation, fine aggregates for use in epoxy mortar shall conform to the requirements of ASTM C-404. The aggregate used in the preparation of the epoxy resin mortar shall be oven dry and shall be conditioned to a temperature of 15^{O}C to 21^{O}C prior to mixing the epoxy resin binder. Gradation of the fine aggregate shall conform approximately to the requirements of Table-L when tested in accordance with ASTM C-136.

Table L

Sieve Size Standard Sq.mesh	**Percentage Passing (by weight)**
No. 4	100
No. 8	95 - 100
No. 16	60 - 100
No. 30	35 - 70
No. 50	15 - 35
No. 100	2 - 5

The aggregates shall be well graded from coarse to fine and the material passing the No. 100 sieve shall be held to a minimum.

10.10 VAPOR BARRIER

Vapor barrier shall be polyethylene building film, visqueen standard or approved equal. The film shall be 100 gauge thick. The quality of material shall be approved by the Engineer prior to use in the works.

Vapor 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.

Manufacturer's recommendations and instructions alongwith the sample of material shall be submitted to the Engineer for his approval.

11. EXECUTION

11.1 PROPORTIONING OF CONCRETE

11.1.1 General

Trial mixes and tests shall be made by the Contractor for the purpose of designing the mixes and for quality control with regard to the required strength, density and durability. The proportions shall be changed whenever such change is necessary to maintain the standard of quality required for the structures and to meet the varying conditions encountered during construction.

All materials composing the concrete shall invariably be measured by weight or if approved by the Engineer as an exception by volume.

11.1.2 Cement Content

The cement content of concrete for various grades shall be established by trial mixes and shall depend on the size, type and gradation of aggregate used, water cement ratio required for the structure and on the requirements of concrete strength, durability and workability.

11.1.3 Aggregate Content

The maximum size of aggregate (MSA) to be used in the various parts of the structure shall be as shown on the Drawings and where not shown, shall be as directed by the Engineer. Concrete mixes shall be designed to use the largest size and maximum amount of coarse aggregate practicable keeping in view the requirements of sub-section 10.2.1

11.1.4 Water Content

The amount of water to be used shall be governed by the following considerations:

WATER CEMENT RATIO: In general, the mix design shall provide for water cement ratios by weight with aggregate at saturated surface dry

condition, which will be determined on the basis of producing concrete having suitable workability, density, impermeability, durability and the required strength without the use of excessive amount of cement.

It is expected that water cement ratio by weight will vary from 0.45 for concrete in thin sections to 0.65 for mass concrete in severe weather conditions. Maximum permissible water cement ratio will also vary from 0.67 for low strength concrete to 0.38 for concrete for higher strength concrete.

CONSISTENCY: The amount of water used in the concrete shall be regulated as required to produce concrete of proper consistency taking into account the effect of any variation in either or both the moisture contents or grading of the aggregates as they enter the mixer. Addition of water to compensate for stiffening of concrete before placing shall not be permitted. Uniformity in concrete consistency from batch to batch shall be ensured.

11.1.5 Concrete Strength

Various classes of concrete shall have 28 day compressive strength of 6 inch x 12 inch test cylinders at least equal to the values given in Table-M except as otherwise indicated on the Drawings or directed by the Engineer.

Class	Cylinder Stgrength Psi
A	4000
B	3000
C	1000

Table -M

11.1.6 Slump

In general, the slump of the concrete, after concrete has been deposited but before it has been consolidated, shall not exceed the values specified below for the structures and/or parts thereof unless otherwise directed by the Engineer. Check slumps shall be taken at the mixer and at locations of placement and or as directed by the Engineer. The Engineer may order the placement of concrete having lesser slump, wherever concrete of such lesser slumps can be consolidated readily into place by means of the specified vibrations. The use of buckets, chutes, hoppers, or other equipment of types that will not readily handle and place concrete of such lesser slumps will not be permitted. The slump will be determined in accordance with ASTM C-143.

The minimum slump shall be ¾ inch in all cases, except when plasticizers are used with the Engineer's approval. The maximum slump shall not exceed the undermentioned limits:

Mass concrete	2 inch
Slabs, floors and foundations	2 inch
Columns, beams, walls, parapets etc.	4 inch
Other parts	3 inch

11.2 BATCHING AND MIXING

11.2.1 Type and Capacity

All concrete shall be produced in a batching and mixing plant or by means of a mechanical mixer as approved by the Engineer.

The capacity of the plant shall be such that the proposed arrangement will produce adequate quantity of concrete to meet with all the other requirements of these Specifications and the construction schedule. The batched materials shall be thoroughly combined into a uniform mixture before the addition of water and admixtures. The water shall be added gradually and the mixer operated for specified duration of time so as to obtain a thoroughly mixed concrete of uniform color and quality.

11.2.2 Mixers

Hand mixed concrete shall not be used; however, the Engineer may allow concrete to be mixed in small mixers. The mixers provided by the Contractor shall be capable of combining the materials into a uniform mixture and of discharging without segregation. Mixers shall not be charged in excess of the capacity recommended by the manufacturer and shall not be recharged before completely discharging the previous batches. Over mixing requiring additions of water will not be permitted. The mixers shall be operated at a drum speed designated by the manufacturer. The mixers shall be cleaned frequently and maintained in satisfactory operating condition, and mixer drums shall be replaced when worn down more than 10 per cent of their length and or thickness.

11.2.3 Water Batcher

A suitable water measuring device shall be provided by the Contractor which shall be capable of measuring water within the specified requirements for each batch. The mechanism for delivering water to the mixer shall be such that no leakage will occur when the valves are closed.

11.2.4 Locations

The concrete plant/mixer shall be installed at the Site at locations selected by the Contractor and approved by the Engineer.

11.2.5 Arrangement

Separate bins and compartments shall be provided for each size or type of aggregate and Portland cement. The compartments shall be of adequate size and so constructed that the materials will be maintained separated under all conditions. Batching equipment/ arrangement shall be capable of delivering concrete within the following limits of accuracy as shown in Table-N

Table-N

Material	Per cent by weight
Cement	+1%
Water +1%	
Aggregate smaller than ¾ inch	+2%
Aggregate larger than ¾ inch	+3%

11.2.6 Cooling

Adequate cooling facilities shall be provided to ensure that the temperature of concrete when discharged from the mixers is sufficiently low to meet the temperature requirements as specified in sub-section 11.4.2. Cool mixing water, ice, precooled aggregate, shading the stockpiles with roofing or any other arrangements may be used to ensure the pre-cooling of the concrete, subject to the approval of the Engineer, but approval shall not in any way relieve the Contractor of his responsibility of placing concrete at temperatures at or below the specified limits.

11.2.7 Scales

Adequate weight and volume batching facilities, as approved by the Engineer, shall be provided by the Contractor for the accurate measurement and control of each of the materials entering each batch of concrete. The accuracy of the weighing equipment shall conform to the requirements of applicable standards. The weighing equipment shall be arranged so that the concrete plant operator and Engineer can observe the dials or indicators. Volumetric measurements, if approved by the Engineer, shall be made by means of accurate measuring boxes.

11.2.8 Mixing Time

The mixing periods specified in Table-O are based on proper control of the speed of rotation of the mixer and of the proper introduction of the materials into the mixer. The mixing time will be increased when such increase is necessary to secure the required uniformity and consistency of the concrete. The mixing time for each batch after solid materials are in the mixer drum, provided that all the mixing water is introduced before one fourth of the mixing time has elapsed, shall be as follows:

Table -O

Capacity of	Mixer Mixing Time
upto 2.0 cubic yards	2.0 minutes
from 2.0 to 3.25 cubic yards	2.5 minutes

11.3 CONVEYING

Concrete shall be conveyed from mixer to the place of final deposit as rapidly as practicable, by methods which will prevent segregation or loss of ingredients and in accordance with ACI-304. Any wet batch hopper through which the concrete passes shall be conical in shape. There shall be no

vertical drop greater than three feet except where the use of such equipment is approved in writing by the Engineer, in advance of any use. Each type or class of concrete shall be visually identified by placing a Colored tag or marker on the bucket as it leaves the mixing plant so that the concrete may be positively identified and placed in the structure forms in the desired position.

11.4 PLACING

11.4.1 General

No concrete is to be placed until all the preparatory works have been satisfactorily completed and the reinforcement and embedded items have been checked and approved by the Engineer. Concrete placing shall follow the practice given in ACI-304.

No concrete shall be placed until all formwork, reinforcement, installation of parts to be embedded, bracing of forms and preparation of surfaces involved in the placing and the method of placement have been approved by the Engineer. Approval of the method of placement proposed will not relieve the Contractor of his responsibility for its adequacy and he shall remain solely responsible for the satisfactory construction of all work under the Contract. Before concrete is placed, all surface upon or against which concrete is to be placed shall be free from standing water, mud, debris or any loose material. All surfaces of forms and embedded material that have become encrusted with dried mortar or grout from concrete previously placed shall be cleaned of all such mortar or grout before the surrounding or adjacent concrete is placed. The surfaces of absorptive materials against or upon which concrete is to be placed shall be moistened thoroughly so that the moisture will not be drawn from the freshly placed concrete. Concrete shall be worked into the corners and angles of the forms and around all reinforcement and embedded items without permitting the material to segregate. Concrete shall be deposited as close as possible to its final position in the forms. The depositing of concrete shall be regulated so that the concrete may be effectively compacted with a minimum of lateral movement into horizontal layers approximately 18 inches in thickness. No concrete that has partially hardened or been contaminated by foreign materials shall be deposited in the structure, nor shall tampered concrete be used unless approved by the Engineer. The surfaces of construction joints shall be kept continuously wet for at least eighteen hours during the twenty-four hour period prior to placing concrete except as otherwise directed by the Engineer. All free water shall be removed and the construction joint shall be completely surface dry prior to placement of concrete. All concrete placing equipment and methods shall be subject to approval of the Engineer. Concrete placement will not be permitted, if in the opinion of the Engineer, weather conditions prevent proper placement and consolidation.

11.4.2 Time Interval Between Mixing and Placing

Concrete mixed in stationary mixers and transported by non- agitating equipment shall be placed within thirty minutes after it has been mixed, unless otherwise authorized. In any case, concrete shall be placed and compacted well within the initial setting time.

11.4.3 Placing Temperature

Placing temperature shall conform to the requirements herein specified for thin and moderate sections. The Engineer's

determination as to the type of section and applicable placing temperatures shall govern. Concrete shall be placed at temperatures as follows:

THIN SECTIONS: Concrete for thin sections shall be delivered to the forms at the coolest temperature which is practicable to produce under current conditions but in no case at a temperature in excess of $30^{O}C$. Except as otherwise determined by the Engineer, sections to which this provision shall apply shall be less than 18 inches in thickness.

MODERATE SECTIONS: Concrete for moderate sections shall have a temperature of not more than $21^{O}C$ when placed. A moderate section will be one that is greater than 18 inches but less than 36 inches in thickness.

11.4.4 Blinding Concrete

Where concrete is to be placed on a flat excavated surface or on an excavated surface inclined at not more than 1V: 1.75 H, a 3 inch layer of blinding concrete, if not otherwise shown on the Drawings, shall be placed immediately after completion of excavation and cleaning. The upper surface of the blinding concrete shall not be higher than the required cover below the lowest layer of the reinforcing steel. The final excavated level shall be calculated to allow for the 3 inch thickness of the blinding layer.

11.4.5 Lifts In Concrete

Concrete shall be placed in lifts or depths as directed by the Engineer. The placement of concrete shall be carried on at such a rate and in such a manner that formation of cold joints is prevented. Slabs shall be placed in one lift, unless otherwise authorized or directed. In walls, lifts shall terminate at such levels as shall conform to structural details. Where slabs and beams are placed continuously with walls and columns, the concrete in walls and columns shall have been in place for at least two hours, or for a longer period when directed by the Engineer, before placing concrete in the slabs and beams. The top surface of vertically formed lifts shall be generally levelled. The concrete in columns shall be placed in one continuous operation, unless otherwise authorized. In general, the construction joints in beams and slabs shall be located as shown on the Drawings and concrete shall be placed in the sequence indicated on the Drawings or as authorized by the Engineer. The maximum differential in height between the various pours of the structure shall be as shown on the Drawings or as directed by the Engineer.

11.4.6 Elapsed Time between Placement of Lifts

Except as otherwise approved on the basis of lift drawings submitted by the Contractor, a minimum of 72 hours shall elapse between the placing of successive lifts of walls and thin sections and 120 hours shall elapse between placing lifts of moderate sections. Thin and moderate sections are defined in sub-section 11.4.3.

11.4.7 Time between Adjacent Pours

The time between adjacent pours shall be defined as the time elapsing from the end of the striking off of one pour to the start of

placing the next pour. The minimum time elapsing between adjacent pours shall be five days for thin and moderate sections and fourteen days for mass section.

11.4.8 Concrete for Blockouts

Blockouts for equipment and fittings and for such other work as indicated or directed shall be provided as indicated on the Drawings. After the said equipment and fitting have been installed and adjusted in their final location, the blockout recesses shall be filled with concrete. Before installing the components to be embedded in blockout concrete and before depositing any blockout concrete, the concrete surfaces of the blockout shall be cleaned in the manner specified for cleaning construction joints.

11.4.9 Placing Concrete through Reinforcement

In placing concrete through reinforcement, care shall be taken that no segregation of the coarse aggregate occurs.

In certain cases, like the bottom of beams and slabs, the congestion of steel near the forms may make placing difficult. In such cases, as decided by the Engineer, a layer of mortar of a composition compatible with the required concrete strength shall be first deposited to cover the surface to a depth of 5/8 inch.

11.4.10 Vibration of Concrete

Recommended Practice given in ACI-309 shall be followed for concrete consolidation. Concrete shall be compacted with mechanical vibrating equipment supplemented by handspading and tamping. In no case shall vibrators be used to transport concrete inside the forms. The vibrating equipment shall be of internal type and shall at all times be adequate in number of units and power of each unit to properly consolidate all the concrete. Form or surface vibrators shall not be used unless specifically approved. The intensity (amplitude) of vibration shall be sufficient (frequency not less than 6,000 impulses per minute) to produce satisfactory consolidation. The duration of vibrations shall be limited to that necessary to produce satisfactory consolidation. Excessive surface working will not be permitted.

11.4.11 Precast Cement Concrete

The work to be done under this item consists of manufacturing, storing, handling, transporting and laying precast concrete members as may be required. Materials and methods for precast concrete work shall conform to the applicable requirements of these Specifications - Plain and Reinforced Concrete. Except as otherwise shown or specified, maximum size of coarse aggregate shall be ¾ inch. Concrete shall be mechanically vibrated in placing. Slump shall be limited to 1-1/2 inch. Precast concrete shall be water cured for 14 days. Precast units shall not be removed until they have attained at least 75% of their required 28 days strength and shall be picked up only by their lifting hooks. The precast members which are subjected to overstress or otherwise injured during curing or handling shall be removed from the Site by the Contractor.

11.5 EXPANSION, CONTRACTION AND CONSTRUCTION JOINTS

11.5.1 Construction Joints

GENERAL: As soon as a lift is completed, the top surface of concrete and reinforcing dowels shall be immediately and carefully protected from any condition that may damage the concrete surface and the dowels. The construction joints shall be prepared as per satisfaction of the Engineer.

CLEANING: Horizontal construction joints on lifts with relatively open and accessible surfaces shall be prepared for receiving the next lift by cleaning with either wet sandblasting or by air- water cutting. Approved wet sandblasting equipment shall be provided. If the surface of a lift is congested with reinforcing steel and is relatively inaccessible or if for any other reason it is considered undesirable to disturb the surface of a lift before it has hardened, surface cutting by means of air-water jets will not be permitted and the use of wet sandblasting will be required.

AIR WATER CUTTING: Air-water cutting of a construction joint shall be performed when approved by the Engineer. The surface shall be cut with a high-pressure air-water jet to remove all laitance and to expose clean, sound aggregate, but not so as to undercut the edges of the larger particles of the aggregate. The air pressure used in the jet shall be 0.7 MPa plus or minus 10% (100 psi) and the water pressure shall be just sufficient to bring the water into effective influence of the air pressure. After cutting, the surface shall be washed and rinsed as long as there is any trace of cloudiness of the wash water. The surface shall again be washed with an air-water jet while the concrete is still green, say well within 6 hours of concreting, (depending upon the atmospheric conditions of humidity and temperature) prior to placing the succeeding lift. Where necessary to remove accumulated laitance, coatings, stains, debris and other foreign material, wet sandblasting will be required immediately before placing the next lift to supplement air-water cutting. When approved by the Engineer, a retarder may be applied to the surface of the lift in order to prolong the period of time during which air-water cutting is effective. Prior to receiving approval, the Contractor shall furnish technical data and samples of the retarder to be used and shall demonstrate the method to be used in its application.

WET SANDBLASTING: When employed in the preparation of construction joints, wet sandblasting shall be performed immediately before placing the following lift. The operation shall be continued until all laitance, coating, stains, debris and other foreign materials are removed. The surface of the concrete shall then be washed thoroughly to remove all loose material.

JOINTS: Vertical construction joints shall be prepared similar to the horizontal construction joints. Where allowed by the Engineer, the inner surface of the formwork may be coated with an approved set-retarder to facilitate the preparation of the vertical construction joint.

WATER DISPOSAL: The method used in disposing of water employed in cutting, washing and rinsing of concrete surfaces shall be such that the waste water does not stain, disColor, or effect exposed surfaces of the structure. Methods of disposal shall be subject to approval by the Engineer.

11.6 INSTALLATION OF WATER STOPS

11.6.1 General

Except as otherwise shown on the Drawings, waterstops shall be installed with an approximately equal width of material embedded in concrete on each side of the joint. Water stops shall be sealed to other cut off systems as shown on the Drawings or as directed by the Engineer. All waterstops shall be installed and carefully positioned so as to form a continuous water tight diaphragm in each joint. All splices shall be neat with the ends of the joined materials in true alignment.

Concrete shall be carefully placed and vibrated around water stops to ensure maximum concrete imperviousness and density, the complete filling of the forms in the vicinity of the waterstop and complete contact between the concrete and all surfaces of water stop.

11.6.2 PVC Waterstops

Splices in the continuity or at the intersections of run of PVC waterstops shall be performed by heat sealing the adjacent surfaces in accordance with the manufacturer's recommendations or as directed by the Engineer. A thermostatically controlled electric source of heat shall be used to make all splices . The correct temperature at which splices should be made will differ with the material used but should be sufficient to melt but not char the plastic. After splicing, a remoulding iron with ribs and corrugations to match the pattern of the waterstop shall be used to reform the ribs at the splices. The continuity of the characteristic components of the cross-section of the waterstop design (ribs, tubular center axis, protrusions, and the like) shall be maintained across the splice. The splices joints shall be tested in accordance with the applicable standards and as directed by the Engineer.

11.7 CURING

11.7.1 General

All concrete including concrete repair work shall be cured by an approved method or combination of methods in accordance with ACI-308. The Contractor shall have all equipment and materials needed for adequate curing and protection of the concrete on hand and ready to use before actual concrete placement begins. Means shall be provided for the protection of concrete from the sun, drying winds and traffic until the specified curing has been completed.

The curing medium shall be applied so as to prevent loss of moisture from the concrete. Concrete shall be protected from heavy rains for 24 hours. All concrete shall be adequately protected from damage. No fire or excessive heat, including the heat resulting from welding, shall be permitted near or in direct contact with the concrete at any time. All galleries, conduits and other formed openings through the concrete shall be closed during the curing period.

If during the specified minimum period of curing, the surface temperature of the concrete falls below $10^{o}C$, the period of curing shall be extended to allow the concrete to reach sufficient maturity. The period of extension shall be as approved by the Engineer.

11.7.2 Moist Curing

Concrete shall be moist-cured maintaining all surfaces continuously (not periodically) wet for 14 days immediately following the placing or until covered with fresh concrete. Precast elements shall also be water-cured for 14 days. Curing water shall be removed without allowing stagnant pools of water to form on the exposed lift surface. Water for curing shall comply with the applicable requirements of sub-section 10.3 “Water”. Where forms of tongue-and groove or shiplap sheating are used and are left in place during curing, the sheathing shall be kept wet at all times. When in contact with concrete, steel forms shall be kept wet. Horizontal construction joints and finished horizontal surfaces cured with sand shall be covered with a minimum uniform thickness of 2 inch of sand and kept continuously saturated with water.

11.7.3 Liquid Curing Membrane

An approved curing compound conforming to ASTM C 309 shall be applied in accordance with the manufacturer's recommendations immediately after any water sheen which may develop after finishing has disappeared from the concrete surface. It shall not be used on any surface against which additional concrete or other material is to be bonded unless it is proven that the curing compound will not prevent bond or unless positive measures are taken to remove it completely from such areas.

11.8 REPAIR OF CONCRETE

11.8.1 General

Concrete that is damaged from any cause; concrete that is honeycombed, fractured, or otherwise defective; and concrete which, because of excessive surface depressions, must be excavated and built up to bring the surface to the prescribed lines; shall be removed and replaced with drypack mortar, or concrete, as hereinafter specified. Repair of concrete shall be performed only by skilled workmen and within 24 hours of removal of forms. The Contractor shall keep the Engineer advised as to when repair of concrete will be performed. Unless an inspection is waived in each specific case, repair of concrete shall be performed only in the presence of the Engineer. Repairs shall be made in accordance with the procedures approved by the Engineer.

11.8.2 Materials

All materials used in the repair of concrete shall conform to the applicable requirements of the Specifications.

11.8.3 Protrusions

Where bulges and abrupt irregularities protrude outside the specified limits on formed surfaces not to be concealed permanently, the protrusions shall be reduced by bush-hammering and grinding so that the surface irregularities are within the specified limits.

11.8.4 Depressions

GENERAL: All fillings for depressions shall be bonded tightly to the surfaces of holes and shall be sound and free from shrinkage cracks and dummy areas after the fillings have been cured and have dried. All fillings in surfaces of structures prominently exposed to public view

shall contain sufficient white Portland cement to produce the same Color as that of the adjoining concrete. Repairs shall be made with non-shrink grout, guniting or drypack filling except where repairs with epoxy concrete and/or epoxy mortar are directed to be made by the Engineer. Concrete, mortar, grouting, guniting or drypack mortar filling as the case may be shall each be mixed in proportions approved by the Engineer to produce a repair at least equivalent in strength density and durability to the concrete in which the repair is required and shall match with the adjacent surfaces in texture, Color and shade.

CONCRETE FILLING: Concrete filling shall be used for holes extending entirely through concrete sections; for holes in which no reinforcement is encountered and which are greater in area than 1.0 square feet and deeper than 4 inch; and for holes in reinforced concrete which are greater than 0.5 square feet in area and which extend beyond the reinforcement.

MORTAR FILLING: Mortar filling, placed under impact by use of a mortar gun, may be used for repairing defects on surfaces, not exposed to public view where the defects are too wide for drypack filling and too shallow for concrete filling and no deeper than the far side of the reinforcement that is nearest to the surface.

DRYPACK MORTAR FILLING: Drypack mortar fillings shall be used for filling holes having a depth nearly equal to, or greater than, the least surface dimension; for narrow slots cut for repair of cracks; for grout pipes recesses; and for tie rod fastener recesses as specified. Drypack mortar shall not be used for filling behind reinforcement or for filling holes that extend completely through a concrete section. If removal of the ends of form ties results in recesses, the recesses shall be filled with drypack mortar provided that filling of recesses in surfaces upon or against which fill material or concrete is to be placed will be required only where the recesses are deeper than 1 inch in walls less than 12 inch thick.

SURFACE FINISHES OF REPAIRED AREAS: The Contractor shall correct all imperfections on the concrete surface as necessary to produce surfaces that conform to the requirements specified for the adjacent area. Fins and encrustations shall be neatly removed from the surfaces.

11.9 EPOXY CONCRETE AND MORTAR

11.9.1 Mixing and Batching

EPOXY BINDER: Prior to mixing, the two components of the epoxy resin binder shall be conditioned to $15^{o}C$ to $21^{o}C$. The two components shall be combined with constant stirring, and the stirring shall be continued until a uniform mixture is obtained. The rate of mixing should be such that entrained air is held to a minimum. A power-driven (air or sparkproof) mixer with propeller-type blade operating at a maximum of 500 rpm shall be used for mixing the two components of the epoxy resin binder and a hemispherical bottomed polyethylene or metal container shall be used for the mixing.

EPOXY CONCRETE: Epoxy binder shall be prepared as specified above, and after the two components have been thoroughly mixed, shall be transferred to large metal pans and the aggregates added in

recommended and approved proportion as specified in sub- section 10.2.6.

The fine aggregate shall be added to the epoxy resin binder and the material shall be mixed until a rich mortar consistency is attained. The coarse aggregate shall then be added and the epoxy concrete thoroughly mixed.

MORTAR: Epoxy binder shall be prepared as specified above in para - Epoxy Binder. After the two components have been thoroughly mixed, the binder shall be transferred to large metal pans and the fine aggregate added in recommended and approved proportions as specified in sub-section 10.2.5. The fine aggregate shall be added to the binder gradually and mixing continued until all particles are coated.

11.9.2 Temperature, Moisture and Protection for Epoxy Mortars and Concrete

Epoxy concrete and mortar shall be placed and repairs shall be made when the atmospheric and concrete temperature are above $5^{o}C$ and less than $38^{o}C$ and remain in this range for a period of at least 24 hours. If the work is required to be done at temperatures lower or higher than those specified; approved means as recommended by the manufacturer of the epoxy binder and approved by Engineer shall be provided to raise or lower the ambient and concrete temperatures as required for satisfactory work. Such means will include heating or cooling equipment and necessary shelters. If temperatures below $5^{o}C$ are anticipated during the cure-out or hardening period of the epoxy concrete or mortar, heated enclosures shall be maintained over the repair area with care taken to avoid localized heating or hot-spots. Circulating air shall be used to ensure that surface temperatures do not exceed $35^{o}C$ during curing. Epoxy resin concrete and mortar shall be placed only on sound, clean and dry surfaces. Suitable methods shall be used to dry and to maintain dry the contact surfaces of the concrete to which the epoxy concrete or mortar is to be applied. All repairs shall be protected from rain or seepage water for at least 24 hours and from all types of traffic for a period of 72 hours.

11.9.3 Preparation and Placing

EPOXY CONCRETE: All fines, dust, and other loose material on the contact surface shall be removed by scrubbing with a stiff bristle brush followed by washing. The dry, cleaned surfaces shall receive a prime coat of epoxy resin. The prime coat shall be applied in a thin coat and briskly scrubbed into the dry concrete surface with a stiff bristle brush. Placement of the epoxy resin concrete shall be delayed until the prime coat becomes tacky. The epoxy resin concrete shall be placed in layers not over 4 inch in thickness. The thickness of courses and time interval between courses, shall be such that the temperature of the epoxy concrete does not exceed $60^{o}C$ at any time during hardening. Mechanical plate, screed or float vibrators or hand tampers shall be used to consolidate the epoxy concrete. Excess epoxy concrete which becomes spread on the adjacent surfaces of hardened concrete shall be removed before it hardens.

EPOXY MORTAR: Defective concrete in areas as determined by the Engineer, shall be repaired with the aid of a saw cut at least 1 inch

outside the faulty area. The concrete between the saw cut and the edge of the faulty area and the concrete throughout the area shall be chipped out to solid concrete. The cavity thus formed shall be thoroughly cleaned with compressed air, sand blasting or other method to remove all loose material. The dry, cleaned surfaces of the cavity shall receive a prime coat of epoxy resin binder of composition as recommended by the manufacturer of the epoxy. The prime coat shall be applied in a thin coating and scrubbed into the surface with a stiff bristle brush. Placement of epoxy resin mortar shall be delayed until the prime coat becomes tacky. The epoxy mortar shall then be placed in the cavity in layers not exceeding 1 inch in thickness. The time interval between placement of additional layers shall be such that the temperature of the epoxy resin mortar does not exceed $60^{o}C$ at any time during hardening. Mechanical plate, screed or float vibrators or hand tampers shall be used to consolidate the epoxy resin mortar. Excess epoxy resin mortar, which becomes spread on the adjacent surfaces of the hardened concrete, shall be removed before it hardens.

11.10 Health and Safety Precautions

- Full face shields shall be used during all mixing and blending operations and for placing operations as required.
- Protective skin creams of a suitable nature for the operations shall be used.
- Portable eye washing facilities shall be maintained at mixing, batching and placing operations.
- Adequate fire protection shall be maintained at all mixing and placing operations.
- Smoking or the use of spark or flame producing devices is prohibited within 50 feet of mixing and placing operations.
- The mixing, placing, or storage of solvent is prohibited within 15 feet of any vehicle, equipment or machinery which could be damaged from fire or could ignite vapors from the material.
- Contaminated clothing which cannot be decontaminated shall be burned at an approved burning area at the end of each working day.
- Facilities shall be provided for decontamination of clothing and equipment at the job site.
- Care should be taken in handling solvent for cleaning equipment to avoid problems of toxicity, fires and possible explosions.
- Adequate ventilations shall be provided.

11.11 FINISHES AND FINISHING

11.11.1 General

Allowable deviations from plumb or level and from the alignment, profile grades and dimensions shown on the Drawings or specified in sub-section 5 “Tolerances” are defined as tolerances and are to be distinguished from irregularities in finish as described herein. The classes of finish and the requirements for finishing of concrete surfaces shall generally be as specified herein or as indicated on the

Drawings. Finishing of concrete surfaces shall be performed only by workmen who are skilled concrete finishers.

The Contractor shall keep the Engineer informed as to when finishing of concrete will be performed. Unless inspection is waived in each specific case, finishing of concrete shall be performed only in the presence of the Engineer. Concrete surfaces will be tested by the Engineer where necessary to determine whether surface irregularities are within the limits hereinafter specified. Surface irregularities are classified as abrupt or gradual. Offsets caused by displaced or misplaced form sheathing or lining or form sections or otherwise defective form lumber will be considered as abrupt irregularities, and will be tested by direct measurements. All other irregularities will be considered as gradual irregularities and will be tested by the use of a template, consisting of a straight edge or the equivalent thereof for curved surfaces. The length of the template will be 4 feet 6 inch.

The classes of finish for concrete surfaces shall be as shown on the Drawings or as directed by the Engineer. No grinding will be required on formed surfaces other than that necessary for repair of surface imperfections as specified herein.

11.11.2 Ordinary Finish (OF)

Ordinary finish (OF) applies to surfaces upon or against which fill material or concrete is to be placed. If unformed, the finishing operation shall consist of sufficient levelling and screeding to produce even uniform surfaces. When formed, the surfaces require no treatment after form removal except for repair of defective concrete and filling of holes left by the removal of fasteners from the end of the tie rods as required under sub-section 11.8 –“Repair of Concrete”. Correction of surface irregularities shall be required for depressions only and only for those which exceed 1 inch when measured as described in sub-section 11.11.1.

11.11.3 Rough Concrete Finish (RC)

Rough concrete finish (RC) applies to surfaces which are intended to receive tiles, metallic lining or other applications as indicted on the Drawings. After consolidation and levelling of the concrete to the specified tolerances, the surface shall be roughened with stiff brushes or rakes before final set. Where rough concrete finish is specified for wall surfaces, the same shall be obtained by use of formwork suitable to produce the required finish. Surface irregularities measured as described in sub-section 11.11.1 General, shall not exceed ¼ inch for floors and 1/8 inch for walls.

11.11.4 Ordinary Slab Finish (OS)

Ordinary slab finish (OS) applies to floor surfaces which are not intended to receive any floor coverings. After the concrete has been placed, consolidated, struck-off and levelled, and its surface has stiffened sufficiently, floating shall be performed by use of hand or power driven equipment, and shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. Floating shall be continued until a small amount of mortar without excess water is brought to the surface so as to permit effective trowelling. Steel trowelling shall be started when the surface has hardened sufficiently to prevent excess of fine material from being

drawn to the surface. Steel trowelling shall be performed with firm pressure such as will flatten the sandy texture of the floated surface and produce a dense uniform surface, free from blemishes and trowel marks. Surface irregularities measured as described in sub-section 11.11.1 General, shall not exceed ¼ inch for abrupt irregularities and ½ inch for gradual irregularities and ½ inch for gradual irregularities.

11.11.5 Fair Faced Finish (FF)

Fair Finish (FF) shall be applied to all exposed surfaces of walls and ceilings which are not to be covered by any other finish. Surface irregularities shall not exceed 1/8 inch for abrupt irregularities and ¼ inch for gradual irregularities, when measured as described in sub-section 11.11.1 All abrupt irregularities and all gradual irregularities in excess of 6 mm shall be reduced by grinding to conform to the specified limit for gradual irregularities.

12. MEASUREMENT AND PAYMENT

12.1 General

12.1.1 Except as otherwise specified hereunder, measurement of concrete shall be made on the basis of the actual volume of concrete in place within the neat lines of the structure, as indicated on the Drawings. Measurement for payment shall not be made of concrete, nor any ingredients including cement in concrete, which is placed outside of the paylines shown on the Drawings. Measurement of concrete placed against the sides of any excavation without the use of intervening forms shall be made only within the pay lines of the structure. Unless otherwise specified, payment for concrete shall be made at the respective contract unit price per cubic feet for the various items of the Bill of Quantities, which price shall include the cost of all labor, materials and the use of all equipment and tools required to complete the batching, mixing, transporting, placing, protecting, curing and other concrete work; except the reinforcement, waterproofing and embedded parts which are specified to be paid for separately. The Contract unit prices per cubic metre for concrete will include the cost of formworks, form oils, aggregates, water, preparation of all type of joints, bond breaking and curing compounds, handling and incorporating the cement admixture into the work, mixing, cooling, specified cleaning and other preparation of surface to receive concrete, placing, finishing, curing and all other work required to complete the concrete structures. No measurement or payment shall be made for removal and replacement of rejected concrete with Portland cement mortar, epoxy concrete, epoxy mortar or by any other method.

12.1.2 No measurement and payment shall be made for testing of cement; sampling and testing of aggregates; providing and testing concrete for slump and compressive strengths on the basis of test cylinders as specified or cubes if approved by the Engineer; providing and designing the trial mixes and testing for each grade of concrete as required by the Engineer and other tests as specified to be made in the laboratory at Site and/or in a laboratory approved by the Engineer.

12.1.3 No measurement and payment shall be made for providing samples and testing precast concrete units manufactured outside the Site;

admixtures; waterstops; embedded items; expansion/contraction joint filler materials, Aluminum strip cover etc. cost of which shall be deemed to be included in the cost of respective item.

12.2 Measurement

12.2.1 Concrete shall be measured as per approved execution, and no deduction shall be made for the following:

- Volume of any reinforcing steel embedded in the concrete.
- Volume occupied by water pipes and conduits etc, not exceeding 4 sq. inch each in cross-sectional area.
- Voids not exceeding 1.0 sq. ft. If any void exceeds 1.0 sq. ft total area of void shall be deducted.

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

12.2.3 Concrete work shall be classified and measured separately as listed under the Items of BOQ.

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

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

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

12.2.7 The depth of the beams shall be measured from bottom of the slab to the bottom of the beams except in case of inverted beams where it shall be measured from top of slab to the top of beam. The cross-section of the beam shall be the actual cross- section below or above the slab.

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

12.2.9 Measurement of non-shrink cement grout shall be made on the basis of number of cubic feet of grout acceptably placed in positions as shown on the Drawings or as directed by the Engineer.

12.2.10 Measurement of acceptably completed works of expansion joint shall be made on the basis of the number of square feet of expansion joint for columns and beams and in the unit of running feet for roof slab as shown on the Drawings or as directed by the Engineer.

12.2.11 **Payment**

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

CEMENT PLASTER

1. SCOPE OF WORK.

The work covered by this section of the Specifications consists of furnishing all plant, labor, equipment, materials and performing all operations in connection with cement piaster work, complete in strict accordance with this section of the specifications and the applicable drawings and subject to the terms and conditions of the Contract. The scope of this section of specifications is covered with detailed specifications as laid down herein.

2. APPLICABLE STANDARDS.

The work shall be completed with the requirements of Pakistan, British and ASTM standards.

3. **GENERAL.**

3.1 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 mentioned in B.O.Q. Internal plaster for the buildings for oil the internal surfaces; columns, walls ceilings, partitions, etc. shall be cement piaster finished smooth unless otherwise specified· Whereas the areas like lavatory blocks, bathrooms, stores, or such other places where there is possibility of any dampness occurring, the plaster shall be cement piaster finished smooth with cement niru or as specified in the BOQ. Except as otherwise specified, all plaster work shall be carried out in Conformity with acceptable code of practice for internal and external rendering and finishes·

3.2 Plastering shall not commence until all electric conduits, drainage and sanitary pipes, inlets to tanks, brackets, clamps, sills, doors' and windows' frames and all sorts of inserts and embedded items are fixed in position. It shall be the responsibility of the Contractor to make sure that all such works are 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.

4. **MATERIALS:**

4.1 Cement: Cement for plaster shall be Portland Cement either ordinary, rapid hardening or sulphate resisting cement and shall conform to requirement as described in the specifications of concrete.

4.2 Sand: Sand for plaster shall comply with the requirements of BS-812, BS-119 and ASTM C-144. Lt shall comprise natural sand, crushed stone sand or crushed gravel sand. It shall be hard durable, clean and free from adherent coatings such as clay and from any appreciable amount of clay pellet form. It shall not contain harmful materials to adversely affect the hardening, the strength, the durability or the appearance of the plaster or any materials in contact with it. The quantity of clay, silt and dust shall not exceed 5% by weight for sand or crushed gravel or 10% by weight for crushed stone sand·

The grading of sand for internal piaster work and external rendering shall be within the following limits.

Percentage by weight passing Sieve Sizes			
Sieve Size **MM**	**Gypsum Plaster Under Coats. Not Used.** **%**	**Gypsum Plaster Finishing Coats. Not Used** **%**	**Internal Cement Plaster Work & External Rendering** **%**
5.00	100	100	100
2.36	90-100	100	90-100
1.18	80-90	95-100	70-100
0.6	30.55	30-85	40-80
0.3	5.40	5.50	5.40
0.15	0.10	0.10	0.10

The grading specified above shall be suitable for smooth finishing coats, scraped finishes and for pebble dash or dry dash for textured surfaces, produced by the treatment of the freshly applied final coat with a tool, the coarser particles shall be removed by screening through a 2mm sieve.

4.3 Water: Water for plaster shall conform to requirements as described in the specifications of concrete.

4.4 **Additives:** Additives for controlling the setting and working characteristics of plaster, or for imparting anti-corrosion, fungicidal or water proofing properties, shall be added to the plaster strictly in accordance with the particular manufacturer's specifications and instructions· Good quality hair or manila fiber in reasonably well distributed proportion may be added to the piaster to assist application and reduce droppings· No additives shall be used except as specified in the Contract Documents.

5. **PROPORTIONING AND MIXING.**

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 Bill of Quantities or as directed by the Engineer. Mixing shall be continuous until complete and all ingredients are evenly distributed.

5.2 Only limited water shall be added for proper workability and such quantity of the mortar shall be prepared as that which will 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, Re-tampering shall not be permitted and all mortar which has begun to stiffen shall be discarded.

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.

6. PREPARATION OF SURFACE TO BE PLASTERED.

6.1 Concrete surface to be plastered shall be cleaned to remove all grease, 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.

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. This slurry shall be applied with a stiff brush on surface, which has previously been well wetted. The surface so treated shall be Jeff to cure for three days.

7. APPLICATION OF PLASTER.

7.1 The plaster shall be minimum 12-20mm thick, as mentioned in BOQ and shall not be less than 12mm thick at any internal surface or 20mm at any external surface. The piaster of o thickness less than the specified thickness shall be rejected. If the plaster is to be more than 25mm thick, it shall be done in two coats. The surface of first coat shall be made rough before the second coat is applied. 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. The curing/wetting of the plastered surface shall start immediately after the surface is set i.e. 4-5 hours from the time of finishing. No extra payment shall be allowed for jambs, junctions, comers, edges, round surfaces or for more than one layer of plaster required due to any unevenness in the work done by the Contractor. The plaster work 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 3 meter straight edge and plumb bob.

7.2 Plaster containing cracks, blisters, pits, discoloration or any defects shall not be acceptable. Any such piaster or loose piaster shall be removed and. replaced with plaster in conformity with these specifications and as additionally directed by the Engineer. Contractor shall cut 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. If the Engineer does not accept patch work, he may ask to replace the entire wall, ceiling, area. etc.

7.3 **Cement Plaster Finished with Cement Nero:** The first coat (Scratch coat) of cement piaster is to be applied as specified and immediately while the plaster is still fresh a floating coat of neat cement shall be applied on it and the surface shall be finished smooth by steel trowel. The plaster with wavy surface or trowel marks shall be rejected.

7.4 **Rough Cast Stucco Plaster:** The rough cast finished cement piaster shall be composed as follows:-

First Coat: One part of Portland cement and three parts of sand or as provided in Schedule of Quantities.

Second Coat: Two parts of Portland cement and two parts of shingle or crushed stone or pea size gravel and three parts of sand or as provided in Schedule of Quantities.

The materials shall be mixed in a dry state either by hand or in mechanical mixer. When the materials are thoroughly and uniformly mixed, then sufficient water shall be added to give workable consistency. The thickness of the first or strengthening coat shall not exceed 15mm or be less than 10mm. When this coat has commenced to dry and harden, it should be combed when evenly distributed, wavy horizontal combing about 15mm apart, and not more than 3mm deep. The thickness of the final coat shall be controlled by texture required by the Engineer-in-Charge shall not be less than 6mm or more than 10mm,

7.5 **Washed Terrazzo Finish:** The washed terrazzo finish on interior or exterior surfaces shall be composed as follow.

First Coat: The composition and application of this shall be similar to the first coat of Stucco plaster above.

Second Coat: One part of white or grey Port and Cement as provided in Schedule of Quantities and two parts of marble chips.

The materials of the second coat shall be hand mixed in a dry state before sufficient quantity of water is mixed to give a workable consistency. When this coat has commenced to set, (approximately 30-45 minutes after application) it should be washed and slowly scraped with a brush to expose the aggregate. The thickness of the second coat shall be between lO-12mm as required by the Engineer-in-Charge.

7.6 **Water-Tight Cement Plaster for Damp-Proof Course**: This type of plaster, where specified, shall be carried out very carefully. The cement sand proportions shall not be less than 1:3 or as specified. The wafer tight reagent such as "Pudlo" or approved additive shall be mixed dry with the cement sand

mixture in the quantity specified in the schedule of description of works. The sand for this item shall be specially selected. The cement, sand and powder are thoroughly mixed and water is added to the extent, it is required to make the paste to apply as piaster. Water should be added to that much mixture of cement, sand and powder, as would be used within the initial set, as per instructions of the manufacturers. The surface plastered shall be thoroughly protected from dry winds and the sun and kept wet for at least 10 days.

7.7 **Drip Courses and Moldings:** Drip course is to be provided in all projections, whatever the nature of cantilevers projections in sills or architraves, etc., may be. Where drip course is to be provided in cast-in-situ concrete it may be cast by placing an inch dia. bar at the position where the drip course is required. Every care shall be taken to see that the drip course is exactly horizontal and parallel to the face of the wall. Drip courses made out in piaster shall be made of richer mix than the plaster and shall be uniform in width and depth and preferably horizontal. Moldings at ceiling or around openings shall be made as shown in the drawings.

8. METAL LATH AT JUNCTION OF CONCRETE & MASONRY, CONDUIT CHASES, ETC.

Metal lathing, at the junction of concrete & masonry, conduit chases, etc., 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.
Before plastering, wherever masonry meets with reinforced concrete members a 200mm wide continuous strip of expanded metal lath shall be nailed to the masonry and the reinforced concrete member covering the joint completely to prevent cracking of the joint.

9. BEADS AND PROFILES.

Angle beads, corner beads, stop beads, architraves beads, depth gauge beads, edging profiles, plaster dividing profiles, interior angle profiles, plaster borders and the like shall all be manufactured from sheet steel and galvanized after fabrication, all beads and profiles shall be perforated at edges to ensure good adhesion of the plaster work. Thickness and dimensions shall suit particular locations and plaster work thickness.

Nails for fixing metal lathing shall be galvanized and have either clout heads or small flat heads to suit particular locations. All angle beads, stop beads, architrave beads, depth gauge beads, and the like are to be fixed in accordance with the manufacturer's instructions.

10. CLEANING AND PROTECTION.

10.1 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.

10.2 Prior to plastering all aluminum windows and finished metals should be covered by sheet of plastic or tarpaulin to protect them from damage.

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

11. TOLERANCES.

Surfaces of plaster work shall be finished with a true plane to correct line and level with all angle and corners to a right angle unless otherwise specified and with wails and reveals plumb and square.

Maximum permitted tolerances shall not exceed 3mm in 2m variation from plumb or level in any exposed line or surface and 1.5mm variation between planes of abutting edges or ends.

12. MEASUREMENT AND PAYMENT.

12.1 General

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

12.1.2 Joints, junctions, jambs, corners, drip course, edges and Rounding.

12.1.3 More than one layer due to any unevenness in the work done by the Contractor.

12.1.4 Cuffing and patching of all defective works.

12.1.5 Surface preparation, cleaning, providing expanded metal lath and protections as specified.

12.1.6 Water proofing agent for water-proof plaster.

12.1.7 Angles beads, corners, beads, stop beads, architraves beads, depth gauge, edging profiles, plaster dividing profiles, interior angle profiles and piaster borders used in plaster works as shown on drawings if these are required in the respective items of Bill of Quantifies.

12.2 Plain Piaster.

12.2.1 **Measurement** : Deductions shall not be made for ends of joints, beam posts, etc., and openings not exceeding 0.5 square meter each and no addition shall be made for reveals, iambs, soffits, sills, etc. of these openings nor for finishing the plaster around ends of joints, beams posts etc. In case of opening of area exceeding 0.5 square meter each, deduction shall be made for the openings and addition shall be

made for reveals iambs, soffits, sills, etc. of these openings. Measurement for acceptably completed works of plaster will be made on the basis of number of square meter of the surface area plastered as shown on the Drawings or as directed by the Engineer.

12.2.2 Payment: Payment will be made for acceptable measured quantity of plaster on the basis of unit rate per square meter quoted in the Bill of quantities and shall constitute full compensation for all the works related to the item.

12.3 **Water Proof Plaster.**

12.3.1 Measurement: Measurement for acceptably completed works of water proof plaster will be made on the basis of number of square meter of the surface area plastered as shown on the drawings or as directed by the Engineer.

12.3.2 Payment: Payment will be made for acceptable measured quantify of water-proof plaster on the basis of unit rate per square meter quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

CONCRETE FORMWORK

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 connection with the design, supply and installation of formwork for the purpose of shuttering in concrete work, complete in strict accordance with this section of the specifications and the applicable drawings and subject to the terms and conditions of the Contract.

2 GENERAL

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

3 MATERIALS

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

3.1 Timber

Form framing, sheathing and shoring.

3.2 Plywood

Form sheathing and panels.

3.3 Steel

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

3.4 Form Ties Anchors and Hangers

For securing formwork against placing loads and pressures.

3.5 Coatings

Facilitate form removal.

3.6 Steel Joints

For formwork support.

3.7 Steel frame shoring

For formwork support.

4 DELIVERY AND STORAGE

4.1 Delivery

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

4.2 **Storage**

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

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

5 WORKMANSHIP

5.1 Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete and shall have sufficient rigidity to maintain specified tolerances.

Where required, details and locations of special forms to be used are set out on the drawings. The Engineer shall refuse any work in any part of the building, which has been constructed with a non-approved formwork. The Engineer shall refuse any concreting which will not be perfect or may not conform to the approved model.

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

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

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

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

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

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

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

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

5.9 Whereas-cast surfaces, including natural plywood-form- finish are specified, the panels of material against which concrete is cast shall be orderly in

arrangement, with joints between panels planned in approved relation to openings, building corners, and other architectural features.

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

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

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

5.13 Forms shall be sufficiently tight to prevent loss of mortar from the concrete. Unless otherwise specified in the Contract Documents chamfer strips shall be placed in the corners of forms to produce bevelled edges on permanently exposed surfaces. Interior corners on such surfaces and the edges of formed joints will not require bevelling unless required by the Contract Documents.

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

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

5.16 Form ties shall be constructed so that the ends or end fasteners can be removed without causing appreciable spalling at the faces of the concrete. After the ends or end fasteners of form ties have been removed, the embedded portion of the ties shall terminate not less than 2 diameter or twice the minimum dimension of the tie from the formed faces of concrete to be permanently exposed to view and in no case shall this distance be less than 20 mm. When the formed face of the concrete is not to be permanently exposed to view, form ties may be cut off flush with the formed surfaces.

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

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

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

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

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

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

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

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

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

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

In normal circumstances (generally where temperatures are above 20^{O}C and where ordinary cement is used, forms may be struck after expiry of the following periods.

- Walls, columns and vertical sides of beams : 48 hours or as may be decided by the Engineer.

.

- Side of slab (shores of props left under). : 6 days
- Beams soffits (shores or props left under). : 12 days.

- Removal of shores or props to slabs.
  1. Spanning upto 4 metre 10 days.
  2. Spanning over 4 metre 16 days.

- Removal of shores or props to beams.

  1. Spanning upto 6 metre. 18 days
  2. Spanning over 6 metre 25 days

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

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

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

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

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

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

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

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

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

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

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

5.31 Floors supporting props or shores under newly placed concrete shall have their original supporting props or shores left in place or shall be reshored. The reshoring system shall have a capacity sufficient to resist the anticipated loads and in all cases shall have a capacity equal to at least one half the

capacity of the shoring system above. The reshores shall be located directly under a shore position above unless other locations are permitted.

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

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

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

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

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

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

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

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

6 MEASUREMENT AND PAYMENT

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

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

FLOORING

1. SCOPE OF WORK.

The works covered under this section of specifications consists of furnishing all labor, materials and equipment and performing all operations in connection with laying flooring including bases, dados and skirting in strict accordance with drawings and as specified herein and subject to terms and conditions of the contract documents.

2. EARTH FILL UNDER FLOORS.

The filling inside the plinth up to the required level of the base shall be carried out in layers of not more than 200mm thickness. Each layer shall be thoroughly watered and compacted to minimum 95% of dry density before the next layer is laid. The earth on site from excavation shall be used only if it is suitable, non-expansive and approved by the Engineer.

3. SAND FILL.

A uniform layer of sand shall be laid to the required thickness over the surface of compacted earth. The sand layer shall be compacted in the manner required by the Engineer prior to execution of subsequent item.

4. STONE SOLING.

The quality of stone material shall be as per requirements for best quality work, and shall be approved by the Engineer. The stones shall be laid on edge as approved by the Engineer. When the stones have been rammed in place and the surface is satisfactory, the spaces or voids between and around shall be grouted with cement mortar 1:6 unless otherwise specified. The cement grout shall be poured and broomed into the spaces between the stones. This operation shall be continued until the grout remains flush with the top of the stones. The grout shall be of such consistency that it will flow readily info the spaces between the stones but if must not be so wet that solid matter separates from the wafer. No further work shall proceed on this stone soling until the cement grout has set sufficiently.

5. BRICK PAVING.

The Contractor shall lay brick pavement at locations indicated on drawings or where directed by the Architect/Engineer.

5.1 Materials shall conform to all the requirements specified in Section "Brick Masonry".

5.2 The Contractor shall prepare compacted sub-grade up to 95% of dry density, finished accurately to lines, grades and dimensions shown on drawings or as directed, diagonal herring bone or other pattern as directed by the Engineer. The Contractor shall first make small samples on site and the Architect/Engineer shall select any suitable pattern. The joints shall be 6mm to 9mm thick unless otherwise specified and shall be filled in with approved mortar for full depth as specified. Curing should be made in on approved manner as already explained in section "Brick Masonry".

6. CEMENT CONCRETE.

The base course of cement concrete shall be 1:3:6 concrete unless otherwise specified. The surface of the bed shall be roughened for the grip of the top layer.

7. FLOOR FINISHES.

All floor finishes shall be laid on properly cleaned and prepared sub-floors to the thickness as indicated on the drawings and finished to the satisfaction of Engineer. The Contractor shall make sample panels of floors for inspection and approved by the Architect/Engineer before actual flooring works are taken in hand.

8. CEMENT CONCRETE FLOORS.

8.1 The concrete ingredients shall be mixed in a batch mixer for not less than 1V2 minutes after all ingredients except the full amount of water, are in the mixer The concrete shall be uniform in composition and consistency from batch to batch except when changes in composition or consistency are required. Wafer shall be added prior to, during and following the mixer charging operations. Excessive or over mixing or increasing concrete consistency will not be permitted. The concrete ingredients shall be mixed by volumetric measurement in purpose made boxes approved by the Engineer.

8.2 The screed may be laid when the concrete is still plastic, thus forming a monolithic stab, or on set and hardened concrete in the first case, any foreign material, laitance or water on the surface of the base should be removed shortly before the screed is laid. In the second case the surface of the base concrete should be brushed with a still broom, just before it hardens, to remove all laitance and loose aggregate and at the same time, to roughen the surface to improve the bond. The hardened base should be thoroughly cleaned, wetted, preferably overnight surplus water removed and a grout of cement and water brushed into the surface keeping just ahead of the application of the screed.

8.3 The adhesion between the screed / topping and base shall be tested by tapping the surface with a rod or a hammer. A hollow sound indicates poor adhesion. Loss of adhesion does not necessarily mean that the screed or concrete topping is unsatisfactory. However, when it is accompanied by visible or measurable lifting at the edges of bays or at cracks, the screed or concrete topping may deflect and break under the loads imposed in use and shall be considered unsatisfactory. Where the screed or concrete topping is considered to be unsatisfactory it shall be necessary to redo the whole of the affected bay or bays.

8.4 The tolerance in level over a 2m length shall not exceed +3mm.

9. TERRAZZO FLOORING (IN SITU).

The Contractor shall submit samples of terrazzo flooring required in the various locations and the samples, which Engineer may select for use in the buildings, shall be available for examination and comparison by both the Contractor and the Engineer. The finished floors shall conform in all respects to the characteristics of the samples approved. The size of chips shall be of 3mm to 10mm size and the color will

be as selected by the Architect/Engineer.

The Contractor, after tentative color patterns are approved, shall provide sample panels of cast in place terrazzo wear coat and base, he proposes to use for subsequent approval of the Engineer before proceeding with his work. The thickness of the wear coat shall be uniform and at no point shall if be less than 15mm. Wherever a cove base is required with skirling or dado, the radius shall be uniform and shall be made together with the skirting/dado. Under no circumstances, with a faint at the base to introduce the curvature will be allowed. Finished surfaces of both floors and walls when completed, ground and polished, shall in air cases show uniformly distributed exposed granules or chips, free of undesirable blotches of matrix without marble granules or chips. Uneven distribution in either floor or wall surface will be required to be resurfaced and/or refinished to the satisfaction of the Engineer. All floors shall be adequately cured for a minimum of 14 days after laying by means of sand bunds in panels or as required by the Engineer. During the course of construction of the floors and up to the time of completion of the Project, the Contractor shall protect the flooring from stains and mechanical damage by his workers or by workers of other Contractors/Sub-Contractors. For the latter conditions, he may take assistance from the Engineer if required. However, in the event of damage or staining, the Contractor shall redo certain floor panels or the entire floor within a space as required by the Engineer.

10. **TERRAZZO TILE FLOORING AND STEPS.**

10.1 All tiles shall be of size 300x300mm or 200x200mm size as shown on drawings or as mentioned in the Schedule of Quantifies and shall be perfectly leveled square and true to every surface. Tiles shall be minimum 25mm for 300mm size and minimum 20mm thick for 200mm size with a marble mosaic tapping firmly bonded to a base of cement concrete, manufactured by the dry process and machine pressed hydraulically with a pressure of not less than I50 kg per square centimeter. The thickness of topping shall not be less than 13mm for 300x300mm tiles and 10mm for 200x200mm tiles.

The marble mosaic topping shall be of colors as selected by the Architect/Engineer, including sizes of chips, their color proportion and distribution. All tiles shall be of uniform color and liable to rejection due to difference in any of the above specified conditions.

The file shall be vibrated to an extent that it releases air to the surface and consolidates the aggregate at the wearing surface. Proportion of cement to aggregate shall not be leaner than 1:2 by weight in topping layer. All tiles shall be cured after manufacture for not less than three weeks, prior to delivery at site, or setting up in floors.

If the Contractor is allowed to use ordinary tiles for stair risers he will have to cut the standard files for which no payment for the wastage or cutting will be made. The tiles before being used shall be thoroughly soaked in water for 10 to 20 minutes and stood on their edges to dry for about the same length of time, Any tiles, which have hair cracks shall be rejected. Should the cracks be noticed after the tiles are fixed in position, such tiles shall be replaced at

contractor's cost and risk.

10.2 The terrazzo flies will be 1aid to the required levels and grades over a setting bed of cement mortar comprising of 1 part of cement and 4 parts of sand by specified. The overall thickness of mortar and tile shall be minimum 50mm. The curing period of the setting bed should 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 before the mortar has set. Surplus mortar shall be removed. Floor and wall surfaces to receive the tiles shall be thoroughly cleaned of all dirt, dust, oil and other objectionable matters. Tiles shall be laid out from the center line of each space in on outward direction and the pattern should be made symmetrical with a minimum number of cut tiles. Joints between the tiles shall be of uniform width. Tiles shall be cut with a suitable cutting fool and rough edges shall be rubbed smooth. Tiles shall be laid to the straight edges. The Contractor is required to submit his shop drawing before actual laying of the tiles to show in detail how and where tiles pieces are planned to be laid. The Drawing shall be approved by the Architect/Engineer. After seven days the terrazzo tile floors shall be machine ground to a true even surface using various grades of abrasive stones as required and directed by the Engineer. After the first grinding, the floor shall be grouted with the same color composition as used for its manufacture. The grout shall be of the consistency of thick cream and shall be brushed over the floor to fill in the joints and after 72 hours the grouting coat shall be removed by grinding till a smooth and even surface is obtained. Areas and portion of the floor inaccessible for the grinding machine shall be ground and rubbed by hand. The final glass shall be given by polishing the surface to the satisfaction of the Engineer. The tile floor shall be kept wet for at least 72 hours and no one should be allowed to walk on the tiles during that period.

11. CERAMIC TILE FLOORING AND DADO.

11.1 The tiles shall be of approved manufacturer. These will be either white or colored as specified in the Schedule of Quantifies or as approved by the Architect/Engineer. The tiles shall be free from cracks or crazing, free from twisting and uniform in color and size. Approval of the manufacturer does not relieve the Contractor to carry-out his own checking to ensure that only the best quality tiles are used and all defective tiles are rejected and removed from site immediately.

11.2 Ceramic flies shall be soaked in clean water 24 hours before laying. They shall be laid on cement concrete base of specified grade and the joints filled with neat white or grey cement or as specified including vertical and horizontal covers. 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 before the base has set. Surplus base material shall be removed. The thickness of setting bed shall not be less than 45mm for floor and 12mm for walls. Floor and wall surfaces to receive the files shall be thoroughly cleaned of all did, dust, oil and other objectionable matters. Tiles shall be laid out from the centre line of each space in an outward direction and the pattern should be made symmetrical with a minimum number of cut

tiles. Joints between the flies shall be of uniform width. Tiles shall be cut with a suitable cutting tool and rough edges shall be rubbed smooth. Tiles shall be laid to the straight edges. The vertical comers of the tiles shall be mitred and finished true by rubbing with carborandum stone or by another approved means. The contractor will not be entitled to claim anything extra for cutting the tiles to the required sizes and finishing the edges as approved by the Engineer. The tile floor should be kept wet for at least 72 hours and man traffic should not be allowed on the tiles during this period.

12. **MARBLE TILE FLOORING AND DADO.**

The Contractor shall submit five samples of each marble type indicated on the drawings and the schedule of quantities. These samples must give the representative of the material that he is going to deliver clearly indicating the maximum, minimum and the percentage of variation. After approval and after the material is delivered to site, the contractor is once again required to take approval from the Engineer prior to start of laying.

Marble tiles shall be of uniform size and shall be perfectly leveled and square on all comers. They will be laid to required levels and grade over setting bed of cement mortar comprising of 1 part of cement and 4 parts of sand by volume or as specified. The overall thickness of the mortar and tile shall be minimum 50mm.

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 before the mortar has set. Surplus mortar shall be removed.

Floor and wall surfaces to receive the tiles shall be thoroughly cleaned of all dirt, dust, oil and other objectionable matters. Tiles shall be laid out from the centre line of each space in an outward direction and the pattern should be made symmetrical with a minimum number of cut tiles. Joints between the tiles shall be of uniform width. Tries shall be cut with a suitable cutting tool and rough edges shall be rubbed smooth. Tiles shall be laid to the straight edges.

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

13. **VINYL TILE FLOORING.**

Vinyl tiles shall be of specified sizes and factory finished. Color patterns shall be selected by the Architect/Engineer from the standard range from an approved manufacturer.

The tile shall have an uniform wearing surface and be color-fast to day light. The

material shall be resistant to mild acids, alkalis, oils, and grease.

Adhesives for tile fixing shall be the adhesive recommended by the manufacturer supplying the tiles. After the base is cured, it will be allowed to dry completely and cleaned thoroughly to make it dust, moisture, oil and grease free. Any irregularity on the base shall be filled in and leveled before laying the tiles. An area not exceeding of 2.5 sq.m shall be coated with approved adhesive material. 10 to15 minutes shall be spent for airing the adhesive. Tiles shall be laid starting from one side of the room and shall be so pressed that complete adhesion takes place.

Prior to commencement of work, the Contractor shall submit go the Architect/Engineer samples of Vinyl tiles of all available color and patterns along with the sample of adhesives for approval of the Architect/Engineer. Manufacturer published instructions and recommendation shall also be submitted.

14. **VITRIFIED CLAY TILE FLOORING.**

Tiles shall be of the best quality and of color and size as approved by the Architect/Engineer. The overall thickness of cement sand mortar and tile shall be minimum 50mm. The mortar shall be laid to make up the total thickness of floor finish specified. The surface shall be laid to levels and grade required.

Tiles shall be paid using adequate number of spacer to ensure uniform spaces between adjacent units of the required thickness as indicated on the drawings or Schedule of Quantities. After the tiles are laid, the joints shall be grouted with 1:4 cement sand grout with or as specified in Schedule of Quantities. The grout shall be to tooled in the required shape, and the Contractor shall ensure that all the joints are finished in a uniform manner as per approval of the Sample.

Care shall be take to see that fall tiles are used as for as possible. Where not possible, the edge files shall be neatly cut with an electric saw and the edges rubbed smooth. The edges cut shall be under the wall tile in case of patterned tiles, the tiles shall be laid in such as way that the patterns end symmetrically on two sides.

Tiles shall be cured for 7 days with water and then thoroughly cleaned and dried. Notwithstanding anything written above the manufacturer's printed instructions regarding laying shall be strictly followed. On completion of the flooring, the entire surface shall be acid washed to remove the film of cement from the surface of the tiles, and the cost of this item shall be deemed to have been included in the quoted unit rate of the Bill of Quantities.

15. **MEASUREMENT AND PAYMENT.**

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

a. Grinding, washing, polishing, acid washing and finishing of tiles.

b. Pigments used for making of files or grouting material.

c. Grouting.

d. Adhesive for fixing vinyl tile flooring.

e. Base mortar,

f. Cement mortar for setting tiles.

15.2 Measurement of acceptably completed works of finished floor, dado, skirting, stair finish, etc. will be made on the basis of net finished area laid in position as shown on the drawings or as directed by the Engineer. Exposed edges of tiles, marble, etc. will not be included in the measurements.

Payment will be made for acceptable measured quantity of finished floor, dado, skirting, stair finish, etc. on the basis of unit rate quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the items.

PAINTING AND POLISHING

1. SCOPE OF WORK.

The work covered by this section of the Specification, consists of furnishing all materials, plant, labor, equipment, appliances and performing all operations in connection with surface preparation, mixing, painting concrete works, gates, frames, structural steel works, steel pipes, valves, steel and wooden doors, windows, louvers, wait ceilings and all such surfaces as shown on the drawings/or as directed by the Engineer, the scope of this section of specification is covered with detailed specifications as laid down herein.

2. **GENERAL**

2.1 Where the work or term 'point' and 'polish' is used or referred to throughout the specifications, it shall be interpreted to mean and include the surface finish treatment consisting of any, all or some of the following items :-

Sealers, primers, fillers, body and final coat, emulsion varnish, shellac, wall paper paste, stain or enamels as more specifically defined hereinafter as to kind and quality and function for various surfaces and finishes.

2.2 All paint, polish and necessary materials incorporated in or forming a part thereof shall be subject to the approval and selection for color, tint or finish by the Architect / Engineer.

2.3 in connection with the Architect's / Engineer's determination of color or tint of any particular surface, the depth of any color or tint selected or required shall in no instance be a subject for an additional payment to the Contractor.

2.4 Where a 'two color' or tint combination may be selected or approved for the treatment of any particular surface in any space or room, no additional payment shall be made thereof to the Contractor in any instance.

2.5 Painting of wood work and for plaster surfaces shall be minimum 3 coats work except otherwise specified. Painting of metal surfaces required to be painted, shall be minimum 3 coats work, in addition to the shop protection coats.

2.6 All paints shall be as manufactured locally and approved by the Engineer and shall be brought on to the site in sealed containers and used without any admixture or adulteration except where recommended in the Manufacturer's printed instructions,

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

3. **PREPARATION AND WORKMANSHIP**

3.1 Prior to start of any work the Contractor shall, as a part of his contract, carefully inspect oil surfaces to be painted or finished and notify the Engineer in writing of any defective workmanship, materials, or any other conditions, which in his opinion, will affect the satisfactory execution and /or

performance of his work. No work in this section shall be initiated until all such surfaces or conditions have been corrected. The absence of any such notification will be construed as an acceptance by the Contractor of all such surfaces and later claims of defects in these surfaces that may result in finished surfaces being unsatisfactory to the Engineer will not in any way relieve the Contractor from the responsibility and/or accountability under his guarantee. No work should to be done under the conditions that are unsuitable for the production of good results, nor at any time when the plastering is in progress or is drying, or not dry. Neither paint nor any other finish treatment is to be applied over wet or damp surfaces unless specifically required, nor shall succeeding coats be applied until the proceeding coat is thoroughly dry.

3.2 Before proceeding with any painting or finishing thorough cleaning and removing of all dust from surfaces, which would affect either the satisfactory execution or permanency of the work is necessary.

3.3 All painting materials are to be applied evenly spread and thoroughly brushed -out only by skilled workers. All workmanship shall be executed in accordance with the best acceptable practices applying to the class of work and grade, type and kinds of materials specified.

3.4 Plastered surfaces shall be primed before speckling. After application of primer coat, Contractor shall check all surfaces and do all necessary speckling of cracks, indentations and other imperfections in any approved manner.

3.5 Wood work that is to have a finish treatment, whether executed as field work or shop finished, shall be smooth and free from raised grain or other surface imperfections that affect its appearance and shall be lightly sanded or steel wool during finishing operations. After filler has been applied, if required all nail holes or other similar blemishes shall be carefully stopped with linseed oil puffy.

3.6 Shop coats provided by others, where required or necessary, shall have all bare spots touched up by the Contractor, using same materials as used for shop coat, or other equivalent material, if approved by the Engineer.

4. **MATERIALS.**

4.1 All materials shall be stored and mixed only in spaces assigned for this purpose by the Engineer and all necessary precautions shall be taken to prevent fires by complying with all applicable local fire prevention and safety ordinances. The contractor shall provide galvanized iron pans of suitable size in which all mixing paints shall be placed and no mixing shall be permitted outside of these pans.

4.2 The basic materials entering into the compounding and/or manufacture of all paints, polishes and other treatments referenced herein shall be of the best grade and quality of their respective kinds for the intended purposes. These

shall be the products or formula of recognized and reputable manufacturers of known reliability and integrity subject to the approval of the Engineer and shall conform to the applicable requirements of the British Standard Specifications or approved local standards regarding kind, qualify and finish, Reference herein to specific paint materials is for the sole purposes of establishing a basis of "Minimum Standards" of quality and shall not be construed to be a limit of perfection or quality for any of the materials, ingredients to be furnished or utilized in this work. The Engineer reserves the right to select and / or accept only the best grades of standard products, which in his opinion, will provide a finish of recognized performance and characteristics suitable for their respective surfaces, irrespective of minimum standards reference herein.

4.3 All materials shall be delivered to premises in their original sealed containers or package bearing the manufacturer's name, label and brand, and be mixed and applied in accordance with manufacturer's directions and /or instructions. The mixing of all paint or other covering finish treatments shall be done in premises as and when, if required, under the supervision and direction of the Engineer.

5. **PAINTING TO METAL WORK.**

5.1 All metal work shall have, in addition to shop primer coats, minimum three (3) coats of enamel paint or as incorporated in the Bill of Quantifies, in the manner as specified herein.

5.2 All exposed ornamental and miscellaneous iron and steel shall receive over the shop primer coat, minimum three (3) coats of enamel paints as specified herein or as incorporated in the Bill of Quantities.

5.3 Galvanized iron not previously shop coated shall receive minimum 4 coats, the first coat to be of an approved galvanized iron primer and minimum three finish coats of enamel paint or as incorporated in the Bill of Quantifies.

5.4 Where shop coals and/or priming coats are found to be scratched or abraded they shall be touched up with appropriate paint.

6. **OIL BOUND DISTEMPERING.**

6.1 Distempers shall be of approved quality and make as directed by the Engineer.

6.2 Before work of distempering is commenced, the surface should be cleaned. The surface then must be sized with a priming coat of petrifying liquid of approved manufacture. Distemper shall be applied quickly and boldly with broad stiff brushes of approved make. The brush is to be dipped and stroked cross-wise info the wails and them immediately stroked up and down. This shall be considered to be one coat of distempering. The distemper shall be mixed in the manner specified by the manufacturer and each coat shall be inspected and passed by the Engineer before the next coat is applied.

6.3 The Contractor shall carry out as many coats as specified in the Schedule of Quantities in accordance with the above specifications. The number of coats specified is enough for producing the uniform smooth finish and if the finish produced by the Contractor is not up to the satisfaction of the Engineer, the Contractor will be required to apply more coats, as may be required to produce the specified finish without any additional charges.

7. **SURFACE PREPARATION AND FILLING.**

Ali piaster and masonry surfaces that are to be finished with vinyl emulsion, plastic emulsion or enamel paint shall be prepared as under prior to application of paint finish.

7.1 **NEW SURFACES:** Rub down the surfaces with a sand paper or carborandum stone to remove any 1case material. Check that the surface is thoroughly dry before painting.

7.2 OLD SURFACES: For previously painted surfaces especially white - washed surfaces, scrape down to the bare surface and ensure that the surface is free from any contaminant like grease, oil, etc. and any loose material or dust is completely removed before painting.

7.3 **SEALING:** Apply 1 coat of Alkali Resisting Masonry Sealer and allow to dry overnight. Alkali Resisting Masonry Sealer may be thinned with 10-15% good quality mineral turpentine or white spirit if required due to surface absorption.

7.4 FILLING: Puffy for filling the walls should be made by mixing 4 parts of good quality chalk and one part of Zinc Oxide Powder with Alkali resisting masonry sealer till a smooth knifing paste is formed. Putty should be applied after sealing the walls with Alkali Resisting Masonry Sealer, and after the tilling work is completed and prior to application of the finish paint, the filled surfaces should be dry and properly finished, No filling should be carried out on external surfaces. Each coal of paint shall be allowed to become dry before any subsequent coat is applied. The finished surface shall be free from runs and sags, defective coverage and clogging of lines or angles. Edges of paint adjoining other materials or other colors shall be full and clean - cut without overlapping.

The Contractor shall carry out as many coats as are specified in accordance with the above specifications. The number of coats specified should be enough for producing uniform smooth finish and if the finish produced by the Contractor is not up to the requirement, he will be required to apply as many more coats as may be required to produce the required uniform finish, and no payment for the extra coats applied to produce the desired uniformity will be made.

8. **CEMENT BASED PAINTS.**

8.1 Cement based paint shall be obtained from approved manufacturers. It shall be obtained in sealed tins, which shall be opened in the presence of the Engineer. Only that much quantity of paint should be mixed which can be used in one hour.

Where required, different colors of cement based paints may have to be mixed together to provide the desired shade. The quantities of the various colors required to give the desired shade will be intimated by the Engineer. These shall be mixed in the manner specified by the manufacturer or as approved by the Engineer after which it must be sieved through 200 mesh sieve.

8.2 The surface should be free from dust, dirt, etc., loose material and dirt must be removed by brushing or if necessary by washing and grease, oil paint, varnishes, oil bound distempers, lime wash, etc., shall be completely removed before application of the paint finish.

8.3 Paint Material must be mixed in two stages. First by adding a little quantity of water to form a paste and then further quantity of water to get a mix of liquid consistency, in the first stage one measure of water to two similar measures of point must be thoroughly stiffed and allowed to stand for 10 minutes. A further measure of water should then be added and thoroughly mixed. This mix must be applied within one hour of the mixing. The lid of the container must be tightly shut immediately after the material has been taken out from it. The surface over which the paint is to be applied shall be thoroughly saturated with water immediately before applying the first coat. The paint shall be applied with brushes of approved make and manufacture. The first coat of point shall be well scrubbed into the surface by means of brushes and allowed to set for a period of 24 hours. After this, the second coat shall be brushed-in. After two coats have been applied, the surface should present a uniform smooth surface.

9. **LACUER POLISHING.**

9.1 Clear polyurethane lacquer used on the work shall be of ICI / Berger or an approved make.

9.2 The surface to be lacquer polished should be sand papered and a staining compound should be applied if required.

When the stain coat dries up the surface should be rubbed down with sand paper. Approved polyurethane lacquer of a proprietary brand shall then be applied.

The surface shall then be wiped with o dry cloth and the process repeated several times in succession until the surface assumes the desired degree of gloss as approved by the Engineer.

10. **SAMPLES.**

Prior to the start of the application of any paint and /or finish treatment otherwise, the contractor shall apply samples of the required finish treatments to specific representative wall and ceiling surfaces or other areas or surfaces where indicated by the Engineer. The sizes of the sample paint and finishes shall be as determined by the Engineer.

11. **PROTECTION.**

The Contractor shall protect all the work against damage or injury by his employees or by the materials, tools used in connection with the work of this contract. Any and all work damages as a result of the execution of this shall be repaired at Contractor's expense or if in the opinion of the Engineer it cannot be properly repaired, it shall be replaced with new work by the Contractor without additional compensation. At all times, the general and liberal use of drop cloths shall be a primary requirement for protection purposes.

12. **TOUCHING UP.**

At the completion of all work specified herein, all painted work shall be touched up and restored where damaged or defected and the entire work left free from blemishes, to the complete satisfaction of the Engineer.

13. **CLEANING.**

The Contractor shall clean all paint, spots, dubs, oil and stain from all floors, wood work, glass hardware, metal work, electrical fittings and all similar items, and leave the work in perfect condition, upon completion in every respect to the satisfaction of the Engineer.

14. **SCHEDULE OF MEASUREMENT OF PAINT AREA.**

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

GLASS AND GLAZING

1. SCOPE OF WORK.

The work covered under this section of the Specifications consists of furnishing all labor, equipment, scaffoldings and providing glass, gaskets, sealants, compounds and accessories required for performing alt operations in connections with the installation and setting of glass, glazing and glass blacks and butt jointed glazed partitions complete in every respect in accordance with the Drawings or as directed by the Engineer. The scope of this section of specifications is covered with detailed specifications as fold down herein.

2. GENERAL.

2.1 The glazier must examine the framing and glazing channel surfaces, backing, removable stop design, and the conditions under which the glazing is to be performed. Do not proceed with the glazing until unsatisfactory conditions have been corrected in a manner acceptable to the Glazier.

2.2 **Weather Conditions:** Do not proceed with installation of liquid sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation.

2.3 The Contractor shall submit two samples of each type of glass required. These samples shall be of 300mm x 300mm size or as directed. He will also submit lengths of installed (mock-up) glazing materials together with samples of glazing sealants and glazing gaskets.

2.4 Contractor shall also submit printed materials manufacturer's installation instructions for specified glazing gaskets, compounds, sealants and accessories including description of required equipment, procedures and precautions to be observed.

3. DELIVERY, STORAGE AND HANDLING

3.1 Contractor shall deliver materials in manufacturer's original unopened containers clearly labeled with manufacturer's name and address, material brand, hype class and rating as applicable.

3.2 Contractor shall store the materials in original unopened containers, with labels intact, protected from ground contact and from other elements.

3.3 Contractor shall handle the materials in a manner to prevent breakage of glass and damage to surfaces, and shall exercise exceptional care to prevent edge damage to glass.

4. MATEIRALS,

4.1 Plain and Tinted Glass: Glass shall be free from all blemishes, bubbles, distortions and other flaws of any kind and shall be properly cut to fit the rebates so as to have o uniform clearance round the panels between the edges of glass and the rebates. AH glass shall be of best quality manufacture as approved by the Architect/Engineer. Gloss shall be of plate or float type, in

thickness and size as shown on the drawings or Bill of Quantities. All glass shell be of such quality that surface deterioration' will not develop under normal conditions of use. Glass shall have parallel surfaces and without physical impurities.

4.2 **Glazing Sealants and Materials.**

1. **General:** Provide color of exposed sealant/compound indicated or if not otherwise indicated, as selected by Architect from manufacturer's standard colors, Comply with manufacturer's recommendations for selection or hardness, depending upon the locations of each application, conditions at the time of installation, and performance requirements as indicated. Select materials, and variations or modifications, carefully for compatibility with surfaces contacted in the installation.

2. **One or two part polysulfide glazing sealant:** Elastomeric polysulfide sealant specially compounded and tested to shown minimum of 20 years resistance to deterioration in normal glazing applications,

3. **One port Silicone Rubber Glazing Sealant:** Elastomeric silicone sealant, non-sag. Provide acid type recommended by manufacturer where only non-porous are contacted; provide non-acid type recommended by manufacturer where one or more porous bond surfaces are contacted.

4. **Molded Neoprene Glazing Gaskets:** Molded or extruded neoprene gaskets or the profile and hardness required.

5. **Polyvinyl Chloride Glazing Gaskets:** Extruded, flexible PVC gaskets of the profile and hardness required.

6. **Foam Glazing Tape:** Closed-cell, flexible, self-adhesive, non-extruding, polyvinyl chloride foam tape, recommended by manufacturer; comply with ASTM D 1667.

7. **Setting Blocks:** Neoprene, 70-90 durometer hardness, with proven compatibility with sealants used.

8. Spacer: Neoprene 40-50 durometer hardness, with proven compatibility with sealants used.

9. **Compressible Filler Rod:** Closed ceil or water-proof jacketed rod stock of synthetic rubber or piaster foam, proven to be compatible with sealants used, flexible and resilient, with compression strength for 25% deflection.

10. **Cleaners, Primers and Sealers:** Type recommended by sealant or gasket manufacturer.

5. INSTALLATION OF GLAZING.

5.1 Glazing work shall comply with the recommendations of the glass and glazing materials manufacturers.

5.2 Examine each piece of glass and discard and replace glass with edge damage or face imperfection.

5.3 Clean glazing channels and other framing members indicated to receive glass. Remove coatings, which are not firmly bonded to the substrate, remove lacquer from metal surfaces wherever elastomeric sealants are to be used. Apply primer and sealer to joint surfaces wherever recommended by the sealer manufacturers.

5.4 Trim and clean excess glazing materials from surrounding surfaces immediately after installation and eliminate stains and discolorations.

5.5 Cure glazing sealants and compounds in compliance with manufacturer's instructions, to obtain high early bond strength internal cohesive strength and surface durability.

5.6 No glazing shall be considered complete until and unless paint and other stains have been removed from the surface of the glass.

5.7 While glass operation is in progress, great care shall be taken to avoid breakage or damage to the glass and adjoining glazing. The Contractor shall make good, at his own cost, all glass broken by his workmen while cleaning or carrying out other operations. On the completion of the glazing work, all glass that has been set by the Contractor shall, if it becomes loose, within the maintenance period, be re-fixed at Contractor's expenses.

5.8 The glass panes shall be properly cut to fit the rebates so as to have a uniform clearance of 2mm round the panes between the edges of glass and the frame. In the event that any pane is cut short so that the clearance exceeds the required dimension and renders the gaskets loose, the panes shall be replaced by the Contractor.

5.9 Glass in butt-jointed installation shall be plain or tinted and of sizes and thickness as indicated in the drawings or the Bill of Quantities. The specifications of glass shall be as mentioned above for plain or tinted glass. The glass shall be installed with a uniform spacing between the leaves equal to the thickness of glass but not greater than 10mm. After the glass is placed on location and approved by the Engineer, the space in between shall be completely tilled by a clear or opaque sealant manufactured by Dow Coming or as approved. All edges shall be marked adequately prior to sealant application.

5.10 Glazing vinyl beads and gaskets shall be of suitable size and shape to fit tightly between the glass and the window/door section. The installation shall

be carried out in a manner that the joints are confined to comers of glass panes, and no joint in beads and gaskets are visible on any side of the glass pane after completion of installation.

6. PROTECTION AND CLEANING OF GLAZING.

Remove all smears, labels and excess glazing sealant, leave clean inside and outside and free from scratches. The Contractor shall be responsible for the protection of installed glass. Before final acceptance, damaged or broken glass shall be removed and replaced with new glass of no additional expense to the Owner. All glazed surfaces shall be washed clean both inside and outside prior to final acceptance.

7. MEASUREMENT AND PAYMENT.

7.1 General: No payment shall be made for the works involved within the scope of this section of specifications unless otherwise specifically stated in the Bill of Quantities.

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

7.2 **Measurement:** Measurement of acceptably completed works will be made on the basis of net actual area in square meter / square feet of glozing material provided and installed in position as shown on the drawing or as directed by the Engineer.

7.3 Payment: Payment will be made for acceptable measured quantity of glazing material on the basis unit rate quoted in the Bill of Quantifies. The unit rate shall include the cost of glazing, wastage, sealants and compound for fixing the glass, all hardware fittings as per manufacturer's recommendations or as shown on the drawings. Payment shall constitute full compensation for all the works related to the item.

CARPENTRY AND JOINERY

1. SCOPE OF WORK.

The work covered by this section of specifications consists of providing all labor equipment and materials including performance of all operations in connection with fixing and installation of all wood work and mill work, construction, assembly and surface finish treatment and building in of all cabinet type items, complete in every respect and all related items support, etc., of wood or metal and incidentals, associated wood work appurtenances, the application of all Finish Hardware in connection with finished wood work, strictly in accordance with the requirements and drawings, as specified herein or as required by the Engineer and subject to the terms and conditions of the contract.

2. GENERAL REQUIREMENTS.

2.1 All materials specified herein shall be the products of one mill as for as possible. Only first class cabinet type workmanship will be admissible in execution of this work, performed by artisans skilled in this trade, so as to provide cabinet work of the highest grade, quality, finishing, fixing and installation as per drawings.

2.2 Care shall be exercised to avoid strong contrasts in color and graining of finished wood for all wood surfaces.

2.3 All cuttings, framing and fitting shall be done as required for accommodation of work of other trades. Use of wood chips, or other shrinkage material for leveling or plumbing will not be permitted in any form. Mortise and tennon joints, shall be set in an approved type of glue with wedges and/or pinned. No wood work in the building shall be allowed until such time plastering is entirely dry. As for as practicable, all wood work shall be assembled in shop, painted and finished throughout before fixing/installation in the building.

2.4 In addition to machine sanding, all interior, trim, paneling and wood work shall be smoothened by hand, using ZERO No. sandpaper to give all wood work the required smooth surface for exposed finished treatment and free from machine and tool marks, abrasions, raised grains and other undesirable defects. All wood work shall be fitted to plaster or other finished work in a careful manner so as not to injure these surfaces in any way. Where plaster or other work is damaged or disturbed, it shall be made good and/or restored to its original conditions at the expense of the Contractor.

2.5 The whole of the timber shall be of good qualify, properly seasoned, "free from large, loose or dead, knots, or tight knots, the diameter of which exceeds one quarter of the width of the exposed face, or one inch whichever is less, or injurious open shakes" and shall not contain sap wood and having a moisture content of not more than 15 percent, nor less than 12 percent of the dry weight at the time of fixing.

2.6 All work shall be accurately set out and properly framed together with close

fitting mortise and tennon joints accurately cut and carefully fitted and wedged solid in the best and most substantial manner. The joinery work shall be started after the commencement of the construction of the building but not wedged up until required, for fixing in position within the building. No lathery shall be wedged or built into position until it has been accepted and approved by the Engineer.

2.7 Door frames built into the structure before the surrounding carcass is built shall be set plumb & true and shall be adequately braced and protected against damage during subsequent building operations.

2.8 All timber shall be of first class soft wood /deodar) except those specified in the Bill of Quantities and as shown on the drawings.

2.9 Plywood used for doors, paneling and other similar works shall be shown on the drawings or 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. The veneer shall be of the required thickness and quality including base veneer and shall be impregnated with on approved adhesive and machine compressed. Such machine pressed veneered wood shall be fixed on all sides of the inner core wood (soft wood of approved qualify) after it has been treated with water resistant hot setting glue.

3. DOOR AND WINDOW FRAMES,

3.1 The door and windows frames shall be of the first class soft wood or hard wood as specified in the Bill of Quantities and description of works. These shall be fabricated to the exact sizes and dimensions as provided in the drawings, where the door frames are not to have any sills, the vertical length shall be embedded in the floor. The Contractor shall also fully protect door and window frames from damage or injury during construction and shall replace the damaged or injured frames at his own cost, the frames must have primary coat painted on or before fixing. All framing members shall be properly mortised, tennoned and all joints properly wedged and glued and pinned. The door and window frames shall be secured in place by means of galvanized steel anchors bent up against the back of the iambs and screwed in place and built into the masonry as if is being constructed. There shall be one such anchor near the top and bottom of each jamb not over 90 cms intervals between the top and bottom anchors, Frames shall be secured to the anchors by means of two counter-sunk screws per anchor.

3.2 Wherever the drawings and Bill of Quantities require door and/or frame of metal, these shall be constructed of prime quality galvanized steel of 16 swg unless otherwise specified. The width and shape shall be as indicated on drawings. The frames shall be recessed at the point of location of hinges and shall have integral reinforcement to allow the butt hinges, pivot hinges, door closers and other finish hardware to be screwed on, The door frames shall also have a provision to allow recessed installation of door lock strike plate with a back up boxing to keep concrete away from the lock strike plate. The

number and type of anchors shall be as per wooden frames. These anchors must not be welded onto the inner side of the exposed surface of the frames as indicated in the drawings. Under no circumstances must the Contractor manufacture the metal frames prior to approval of a sample by the Architect/Engineer. The protection of the metal frames from the plastered surface if shown on the drawings must be uniform throughout the project.

4. FLUSH WOOD DOOR SHUTTERS.

4.1 The door leaf has to be flushed type on both sides manufactured as approved. It shall be of well-seasoned solid core black board. Flush door shall be screwed to the frames by means of butt hinges. Hinges where provided shelf be countersunk in the order for veneered leaves shall intimate the Engineer and also a sample of the leaf of the proposed manufacturer, Completed doors shall be sound, rigid and free from defects and warp. All edges shall be aligned and smooth, Joints shall be close fittings, hardwood doweled or mortised frames and of strength to maintain the structural properties of the members connected. All adjoining faces and edges shall be flush and smooth. Edges shall be rectangular and solid. If a lipping is required on the edges of the flush door shutter, this shall be of the required size and shall be recessed and glued and nailed info the edge frame of the shutter.

5. GLAZED DOORS AND WINDOWS.

5.1 All doors and windows Leaves shall be cut out and framed together as soon as possible after the commencement of the works and stacked in the shade for seasoning. These ore not to be wedged and glued for four months where possible and where the contract time permits. If it is not possible, these should be wedged and glued just prior to being hung. Any or all portions, in which defects appear, shall be replaced by the contractor before final gluing up the same. All tennons at the final assembly of the doors (top and bottom) shelf be glued and wedged. Immediately after gluing, the frames shall be tightly clamped and so Jeff till the glue has set. Unless otherwise specified, leaves are to be hung on hinges of the size and numbers required. The hinges shall be countersunk info the frames as well as in the leaf, the recesses being cut of the exact size and depth of the hinges. No subsequent packing shall be allowed.

6. WOODEN HAND RAIL.

The wooden hand-rail shall be in accordance with the dimensions and shape shown in the drawings. If shall be fixed to the balustrades with counter screws at maximum 250mm centers or with bolts in an approved manner and the top neatly covered in with an appropriate wood stopper.

The wood shall be carefully selected and shall be free from all knots in addition to conforming to the specifications for wood work section.

7. WOODEN CABINETS.

All cabinets including fittings and fixtures shall be as approved and shall be of best quality.

7.1 The Contractor shall submit a finished sample of each type of cabinet including all lettings and fixtures and the same shall be got approved from the Engineer before fabrication. Samples of materials to be used in cabinets together with specifications and literature shall be supplied to the Engineer for his approval. The color shade shall be as approved.

7.2 All cabinets shall be installed in position by the skilled workmen. The Contractor shall inspect delivered cabinets and related parts for indication of location, size required by field measurements, finishing hardware and similar preliminary works. Verify locations for installation, required floor and wall finishes, painting and all other related work. Unsatisfactory conditions shall be repaired. Concealed fasteners, all joints surfaces shall be smooth and even. Doors and other moving parts shall exactly fit in the frame. Refit, as necessary to ensure proper and easy operations. Refit, if necessary, all cabinet hardware, test for proper operation, remove for painting and other finishing and properly replace in position with all fittings and accessories. All work shall be thoroughly protected from damage at all times by suitable methods approved by the Engineer, Adjacent work shall similarly be protected from damage. Any damage or disfigurement shall be immediately made good at Contractor's expense.

8. WOOD SKIRTING/DADO AND PANELLING.

Wood skirting/dado and paneling shall be provided where shown on the drawings and the schedule of finishes. These shall be installed in position conforming to detailed drawings and as per direction of the Engineer. Shop drawings and sample shall be submitted to the Engineer for approval. In the event of non-conformance to specifications and drawings, the work shall be rejected by the Engineer and the Contractor shall remove and replace the rejected work by new work as per specification,

Surfaces shall be prepared in the manner as directed by the Engineer for clear polish finish or as specified.

9. HARDWARE.

Hardware shall be of best qualify and make, strong and fine finished according to the weight/dimension, material as per specified hardware schedule. The Contractor shall obtain prior approval from the Engineer for quality, shape, pattern and brand of all hardware materials by providing samples and catalogue 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 info respective lacks and upon acceptance of the work keys shall be tagged and delivered to the Engineer.

10. MEASUREMENT AND PAYMENT.

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

carpentry and joinery works.

a. Glass and glazing including other materials and accessories, required for installation and finishing.

b. Prime coat, painting and polish in carpentry and joinery, works.

c. Adhesives.

d. Fittings and fixtures for moveable panels.

10.2 Measurement of acceptably completed works of all units will be made on the basis of net actual area in square meter / square feet or length in meter / feet fabricated and installed in position as shown on the drawings or as directed by the Engineer.

10.3 Payment will be made for acceptable measured quantity of all units on the basis of unit rate quoted in the bill of quantities and shall constitute full compensation for all the works related to the item.

ALUMINUM WORKS

1 SCOPE

The work under this section of specification includes furnishing all labor, equipment, appliances and materials and performing all operations in carrying out the work of natural, anodized and powder coated aluminum windows, doors, ventilators and louver with fly proof shutters and aluminum false ceiling of polycarbonate sheet on swimming pool. All related items such as sealants, rubber gasket for glazing, netting, rollers, latches, fastenings, glazing, anchor bolts and all items supplied by other trades and customarily built in and/or installed in strict accordance with this section of the specifications and the applicable drawings and subject to the terms and conditions of the Contract.

2 APPLICABLE STANDARDS

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

ISO (International Organization for Standardization

6612 Windows & Doors - wind resistance tests.

6613 Windows & Door - Air permeability test.

BSI (British Standard Institution)

1227 Hinges

4873 Aluminum alloy windows.

3 SUBMITTALS

3.1 Shop Drawings

The contractor shall submit shop drawings which shall show full construction details, quantities and locations, fastenings and attachment to adjacent construction and materials. Shop drawings shall be submitted at the proper time to allow for checking, revisions and to permit manufacturer's product delivery and start of site work to suit the building programme.

3.2 Samples.

Prior to execution of work and sufficiently in advance, the Contractor shall submit representative samples of finished Doors, windows and ventilators, anchoring mechanism, embedded parts, fastenings, glass panes, accessories and other materials for the Engineer's approval.

3.3 Manufacturer’s Certificate

The Contractor shall on request get certificate signed by the manufacturer stating that each lot has been sampled tested and inspected and has met the requirements in accordance with these specification and the same shall be furnished to the Engineer.

3.4 Guarantee

The manufacturer shall furnish his standard written guarantee against leakage of rain water, excessive infiltration of dust, air and all defects in materials, workman ship covering all the work under this section.

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

4 INSPECTION & TESTING

4.1 Contractor shall arrange tests and analysis if directed by the Engineer of scaled models of each Door, window ventilator 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.

4.2 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.

5 PRODUCT DELIVERY AND STORAGE

5.1 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.

5.2 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.

6 MATERIAL

6.1 All the sections used for Doors, windows, ventilators & 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 & B221.

6.2 **Frames**

The frames of aluminum doors, windows, ventilator, louvers and fly proof shutters shall be formed from rolled, strip or extruded aluminum and be at least 2mm thick deluxe section. Fastenings bolts and screws shall be made from hardened aluminum.

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

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

6.5 Hardware as required shall be manufacturer's standard hardware of aluminum, stainless steel or other corrosion resistant materials and shall blend in design with the frame finishes.

6.6 Joint sealant shall be approved elastomer.

6.7 Fittings and fixtures shall be as per approved samples.

6.8 Joint sealant shall be approved elastomer.

6.9 **Finished Coating**

6.9.1 General

The finished coating shall be as stated on the Drawings and applied strictly in accordance with the manufacturer's instructions.

The color of the coating shall be selected from available ranges if not stated if not stated in the drawing and or bill of quantities. The Contractor shall offer samples for approval prior to the final selection and the manufacture of these elements.

6..9.2 **Anodized coating**

The aluminum anodizing shall comply with BS 3987 and be integral color hard coat anodizing 550kp/mm^2 hardness, minimum 25 microns thick.

The color of anodizing shall be as described on the drawings. Samples of color including limits of color variation shall be submitted to the Engineer for his approval before work commences. The Engineer reserves the right to reject the products of any supplier who cannot guarantee a reasonable limit of color variation, the acceptable limit of variation being at the Engineer's discretion.

6.9.3 **Polyester Powder coating**

All aluminum sections that are to receive a polyester powder coating shall be given a caustic etch followed by an anodic oxide treatment to obtain an architectural class 1 anodic coating. Anodization should be not les than 25 micron thickness.

All aluminum works shall be finished in colored electrostatic polyester powder coating as per DIN standard 53151, 53153, 53156 or equal and approved to RAL Color subject to the Consultant's approval.

6.9.4 **Coating Thickness**

As and when instructed by the Consultant, the Contractor shall provide certificates from independent laboratories that the minimum thickness as stated in these Documents has been applied to the aluminum sections. Failure to provide such information shall result in the complete installation being rejected and replaced at the Contractor's expense.

6.9.5 **Dissimilar Materials**

All aluminum surfaces that are to be in contact with cured concrete, mortar, steel and other metals shall have the contact surfaces protected wherever they may entrap moisture or corrosive elements. Metals that are to be in contact with mortar or concrete shall be protected with a two coat bituminous coating.

Prime paint steel parts of anchors, anchor inserts, reinforcement, supports, and all parts after field welding or blotting with zinc chromate. Minimum dry film thickness of 1 mil for zinc chromate.

7 FABRICATION

7.1 General

All nuts, bolts, washers and screws used for assembly and fixing shall be of adequate strength for their purpose within the design and shall be stainless steel grade 18/8.

All sealants used in the assembly of, and in the fixing of cladding and window framing, shall be non-setting to allow thermal movement without detriment to

those joint sealants used for peripheral caulking and shall be one part silicone sealant and shall conform to BS 4245. All spliced joints between mullions will be sealed with an approved silicone product, compatible with other sealants and packing used.

All ironmongery which is to have the same finish as the frames and shall be approved by the Engineer.

At all opening of windows and doors and where there are louvered screens and doors, a fly screen shall be provided to the approval of the Engineer, constructed following the principles and specifications as described elsewhere in this specification.

Glazing sections shall be set in special heat resisting PVC and of channel type. Separate glazing sections on each side of the glass will not be permitted.

The following table indicates the basic requirements for window construction. The weights of framing make no allowance for beads, glazing bars, opening light framing, coupling mullions or transoms.

Classifi-1. Cation	**Min. weight Of basic Frame Kg/m run**	**Max. superficial Area of window In m2**	**Max. Dimension Either way Mm**	**Remarks**
Light	0.60	1	1500	
Light	1.00	3	2000	
Medium	1.50	5	2500	
Medium	2.00	9	3000	
Heavy	2.50	12	3500	
Heavy	3.00	12	3500	With door

7.2 Sliding Windows and doors

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

The rollers for sliding shutters for both windows as well as doors shall be of the adjustable type. The adjusting screws must be accessible in the assembled state of the shutters and a vertical adjustment of 7 mm should be possible.

All sections for sliding windows and doors should be hollow section and the cross section dimensions of the sections should not be less than 60 x 40 mm.

The outer frame must be suitable for accommodating sliding fly screens as required.

The handle-latch set should have all visible surfaces finsihed as the aluminum sections. The handle must have a proper grip. A small projecting flange or recess in the shutter sections cannot be accepted to serve as handles. The

latching mechanism should not be surface mounted but should be concealed within the sections.

Sash rails of vertical sliding windows are to be of tubular box sections with corner joints of outer frames and sashes interlocked, and the balance mechanism is to be an approved proprietary product.

7.3 Side hung windows, doors and ventilators

All windows and doors should be weather-stripped with heat resistant PVC sections. The weather protection should be achieved by a positive compressive action against the PVC section and should not depend on external contact with the PVC section. At every contact between two profiles two weather-stripping section should be provided to complete weather protection.

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

The shutter sections for both windows as well as doors shall be hollow section type and shall be overall size 57 x 45 mm and door sections shall be overall size 81 x 45 mm (including flanges).

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

Hinges shall be anodized aluminum with stainless steel pins and nylon washers. Handles shall be anodized aluminum finished to match the aluminum sections and mounted with self-lubricating nylon washers.

A mortise cylinder rim automatic deadlock of high quality with double pin tumbler is to be used.

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

Fitting where required:

a. Single action door closer concealed in the head bar of the outer frame and mounted on an adjacent pivot at the threshold and deadlock fitted.
b. The left hand leaf of double doors with flush bolts at head and sill with deadlock fitted to the right hand leaf.
c. Escape doors to have panic bolt assembly with vertical elements concealed in the stile and door closer as in (a).

7.4 Fly screens

Fly screens shall be fitted to all opening leaves of windows or sliding doors, consisting of a separate metal sub-frame in with aluminum mesh fly wire. The Fly screens shall be adequately secured with suitable clips, set screws or turn buckles and shall be removable for maintenance purposes. Fly screen doors

shall consist of similar section to metal casement doors and shall be fitted with removable panels of fly wire.

The aluminum frame to the Fly screen shall be finished to match the framing of the window or sliding door. Color and type of mesh to Engineer’s approval.

7.5 Glazing

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. All the glass shall be best quality of approved manufacture or equivalent standard as approved by the Engineer.

7 ERECTION AND WORKMANSHIP

7.1 Erection

7.2 Rawlplugs and anchoring bolts shall be embedded into the concrete or masonry for holding the doors, windows, ventilators and louvers in their correct position.

7.3 Care shall be taken to install the doors and 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 appear on the surface of doors, windows, ventilators and louvers the Contractor shall at his own expense and at the Engineer's direction have all exposed surface cleaned to bare bright metal and made good as required.

All joints between structure and the metal shall be fully caulked and painted. All works shall be installed in strict accordance with the manufacturer’s instructions.

7.4 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 workmanship like manner in accordance with the manufacturer's instructions and as specified herein. All items shall be left in operating, neat and clean condition, free from dirt, finger marks, cement mortar stains 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. Beads and grooves shall be ensured to be clean, dry and unobstructive at the time of glazing. The complete unit shall be airtight and watertight on completion. No door and window shall be considered complete until the finger prints and other stains and marks have been removed from the surface of glass and aluminum.

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

Protective coating shall be applied in the manufacturer's plant to the exposed surfaces of all components after removing all fabrication compounds, mixture and dirt accumulations.

7.5 FINISHING

All exposed surfaces shall be carefully polished and all alloy defects, die marks, scratches, strokes or other surface blemishes shall be buffed to a clear surface and given an anodic oxides treatment. The structural shape of aluminum members shall be of uniform quality, Color and temper; clean, round, commercially straight and free from injurious defects.

8 PROTECTION AND CLEANING

- Temporary protection shall be achieved by applying water soluble protective coating capable of withstanding the action of lime mortar.
- Apply coating in the manufacturer's plant to the exposed surfaces of all components.
- Before application of coating, remove all fabrication compounds, moisture and dirt accumulations.

9 DEFECTIVE WORK

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

10 MEASUREMENT AND PAYMENT

10.1 General

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

- Providing and fixing glazings.
- Rawlplugs, brackets, rubber gasket, sealants, rollers, vetting latches and any other embedded fixture required for fixing the doors, windows, ventilator and louvers.
- Providing and fixing locks, handles and door closers as approved by the Engineer.
- Providing and applying approved joint sealant according to the manufacturer’s instructions
- Providing and fixing fly proof shutters along with aluminum wire gauze to sliding/ open able windows and ventilators.
- Plant, tool and equipment required to fix aluminum at any height.
- Providing and applying approved joint sealant/ aluminum covering where window mullion touches with the wall poly carbonate sheet (lexan) for Swimming pool false ceiling.

10.2 Aluminum Doors, Windows and Ventilators

10.2.1 Measurement

Measurement of acceptably completed works of aluminum doors, windows and ventilators will be made on the basis of net actual area in square feet provided and installed in position as shown on drawings or as directed by the Engineer.

10.2.2 **Payment**

Payment will be made for acceptable measured quantity of all finished aluminum doors ,windows and ventilators on the basis of unit rate per square feet quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

10.3 **Aluminum frame with fixed Ploy carbonate sheet false ceiling on Main Swimming pool**

10.3.1 **Measurement**

Measurement of acceptably completed works of Aluminum frame with fixed Ploy carbonate sheet false ceiling on Main Swimming pool will be made on the basis of net actual area in square feet provided and installed in position as shown on drawings or as directed by the Engineer.

10.3.2 **Payment**

Payment will be made for acceptable measured quantity of all finished Aluminum frame with fixed ploy carbonate sheet false ceiling on main Swimming pool on the basis of unit rate per square feet quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

MARBLE

1 SCOPE

The work done under this section of specifications, consists of providing all material, labor, plant, equipment, appliances and performing all operations required for providing and installing marble natural stone slab and tile finishes in floor, skirting, stair case portion of exterior walls, kitchen and toilet counters, flower beds, and verandahs etc. as shown on the drawings, complete in accordance with this section of the specification and the applicable Drawings.

2 SUBMITTALS

2.2 Manufacturer's/Supplier's Product Data

The Contractor shall submit manufacturer's specifications and other product data for each type of marble stone and fixtures required, including instructions for handling, storage, installation and protection.

2.3 Shop Drawings

Shop Drawings shall be submitted showing sizes, dimensions, sections and profiles of slab and tile units, arrangement and provisions for jointing, anchoring, fastening and supports and other necessary fixing details. Indicate locations, layouts and pattern arrangements for each stone type and Color.

2.4 Samples

Submit three sets of range samples not less than 300mmx300mm in size of each type for different Color, grade and finish required include in each set the full range of exposed Color and texture, including material blemishes which may be characteristic of marble selected and to be expected in the complete work.

3 DELIVERY, STORAGE AND HANDLING

Materials shall be protected from damage during loading, shipment, delivery and storage. Non-staining materials for blocking and packing shall be used. Stack marble units at site in accordance with manufacturer's recommendations and as required to prevent staining, scratching, etching or breakage. Marble slabs/tiles shall be delivered finished unless otherwise approved. Damaged slabs/tiles with chipped edges or cracking will not be accepted if such defects are noticeable at a distance of one metre under normal light conditions. Decision of rejection shall be final.

4 TOLERANCES & TESTING

4.1 Tolerances

Fabricate marble Slab/Tiles in accordance with the followings unless otherwise shown.

• Length and Width	1mm (1/16")
• Thickness (depth)	1mm (1/16") where visible6mm (1/4") (where not visible)
• Horizontal and vertical alignment (deviation from straight lines parallel to centre line)	1mm (1/16") 3 M (10ft.) of length
• Out of Square (differences in Length of two diagonal measurements)	1mm (1/16) 3 M (10ft.)

1.1 Testing

The tests for marble shall be made as per B.S. Standards for the determination of:

→ Weight %age Absorption

→ Modulus of Rupture

→ Compressive Strength

→ Resistance to Abrasion

→ Flexural Strength

5 MATERIALS

5.1 General

5.1.1 Obtain each marble stone type from a single quarries from Pakistan and ensure consistent Color range and texture through out the work. It shall have a specific gravity of about 2.7 and of hardness number on Moh's scale shall range 3 to 4.

5.1.2 Provide marble slabs or tiles of specified sizes in floor, wall areas and countertops as shown on drawings.

5.1.3 Provide marble slabs of type, Color and finish for each area as per approved samples by the Architect/Engineer.

5.1.4 Provide marble of specified thickness. Saw-cut the back surfaces that are meant to be concealed in finished work.

5.1.5 Provide irregular shaped units, staircase units and skirting base units and counter tops to the profiles of required shape, with arises sharp, true and matched at joints, polished exposed edges.

5.2 Beds and Backings

Where applicable, standard cementitious screed and mortar beds and backings, mixed and proportioned by volume shall be as follows:

ordinary Portland Cement	1 part
Sand:	3 parts
Water:	Clean, fresh and free from deleterious substances

5.3 Adhesives, Grouts and Sealants

Proprietary adhesives, joint grouts and sealants of approved type as required and recommended by the manufacturer for specific application shall be used. The Color of the joint grout and the sealants shall match with the Color of stone.

5.4 Setting Shims or Buttons

Lead buttons of the thickness required for the joint size shown or specified, and of the size required to maintain uniform joint width.

5.5 Connection Materials

Provide necessary anchorages loose steel plates, clip angles, seat angles, anchors, dowels, clamps, hangers, and other miscellaneous steel shapes for securing marble units to other supporting and adjacent members. Provide at least two anchors for each piece.

6 FABRICATION

6.1 Fabrication Qualification

Fabrication of Marble shall be by a firm which has successfully fabricated marble similar to the quality specified for a period of not less than five years.

6.2 General

Fabricate as shown and as detailed as finial shop drawings. Provide holes and sinkages cut or drilled for anchors, fasteners and supports as shown and as necessary to secure marble in place. Cut and back check as required for proper fit and clearance. Shape beds to fit supports. Provide reinforcing backing as required for adequate strength firmly adhered in place.

6.3 Contiguous Work

Provide chars, reveals, openings and similar spaces and features as required for conuguow works.

Co-Ordinate with drawings and final shop drawings showing contiguous work.

6.3.1 Cut openings for lavatories, plumbing fittings and similar items indicated on the drawings, as specified in other drawings and as required.

7 EXECUTION

7.1 General

The Contractor shall employ skilled and trained marble workers for doing this job. He may be allowed to employ a specialist Sub-Contractor for this item of work with the approval of the Engineer. The surface over which marble slab/title are required to be fixed shall be clean of all dirt and dust and shall be properly hocked so that the mortar sticks well to the surface.

Do not use marble Slab/Tile with chips, cracks, stains or other defects which might be visible in the finished work. Clean stone before setting by thoroughly scrubbing with fiber brush followed by a through drenching with clear water.

7.2 Paving, Flooring, Skirting and Stair

Apply cement slurry coat over surfaces of concrete substrate immediately prior to placing setting bed. Limit area of application to avoid premature drying out. Install setting bed of required thickness and set stone units before initial set occurs. Apply a thin layer of cement paste to bottom of each unit. Set, tamp and level units immediately. Set units in required pattern with uniform joint widths.

Point joints as soon as possible after initial set. Force grout into joints, strike flush and tool slightly concave.

Remove mortar and grout from surfaces while still moist and as the work progresses.

Do not permit traffic on finished surface during setting and for a minimum of 24 hours after final pointing of joints.

7.2.1 BASE

The base in cement concrete if required, the sub base in brick ballast plus sand or lean concrete shall be prepared as provided in "Section Floor and Wall Finishes" cement concrete flooring. The thickness of sub-base if any and base shall be as shown on the drawings or directed by the Engineer. The surface of the concrete base shall be rough finished. The curing period of the base shall be at least 72 hours before laying the marble work.

7.3 Repair and Cleaning

Remove and replace marble units which are broken, chipped, stained or otherwise damaged. Where directed, remove and replace units which do not match adjoining stonework or are not in line and level as shown on Drawings. Provide new matching units, install and point joints to eliminate evidence of replacement. Repoint defective and unsatisfactory joints to provide neat, uniform appearance.

Clean stonework not less than 6 days after completion of work, using clean water and bristle brushes. Do not use wire brushes, acid or caustic type cleaning agents or other cleaning compounds which may be detrimental to the stone finish or joint grout.

7.4 FINISHING AND POLISHING

The Contractor shall make suitable arrangements for giving final finish to the marble tile work such as cleaning, washing and chemical polishing as specified or as directed by the Engineer.

The marble shall be polish finished to a glossy surface that will reflect light to emphasize the Color and marking, produced by a chemical polish applied to a honed surface. All finished surfaces shall be of uniform texture, Color and appearance and shall be in conformity with the sample approved by the Engineer.

7.5 Protection

Provide covers, boards, supports and all other necessary materials to protect finished work from collapse, deterioration, discoloration or damage during installation and until contract completion.

8 MEASUREMENT AND PAYMENT

8.1 General

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

- Finishing, washing, polishing, repair cleaning and protection of marble slab, tiles, in position.
- Appropriate adhesives, joint grouts and sealants for fixing marble tiles, where specified on the Drawings or directed by the Engineer.
- 3:4 thick 1:3 cement sand setting mortar for marble stone/tiles.
- Preparation of concrete substrate for laying marble tiles on floor.
- M.S. angle framing and fixing accessories for marble slab on vanity counter if required
- Cost of factory chemical polish for pre polished marble tile/ slab.

8.2 Marble Slab on Vanity, Kitchen, and Reception Counter

8.2.1 Measurement

Measurement of acceptably completed works of marble slab on Vanity, Kitchen and Reception Counter, will be made on the basis of net actual area in square feet of marble slab provided and laid in position as shown on the Drawings or as directed by the Engineer.

8.2.2 Payment

Payment will be made for acceptably measured quantity of marble slab on Vanity, Kitchen and Reception Counter, will be made on the basis of unit rate per square feet quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

FALSE CEILING

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 connection with providing and installing different types of false ceiling including suspension system complete as shown on the drawing, specified herein and/or as directed by the Engineer.

2 CODES AND STANDARDS

The following Codes and Standards shall be followed wherever relevant and applicable and/or as directed by the Engineer.

CP 290-73	Suspended Ceilings and linings of dry construction using metal fixing systems.
BS 443-82	Specifications for testing zinc coatings on steel wire and for quality requirements.
BS 729-71	Hot dip galvanized coatings on iron and steel articles.
BS 1369-47	Metal lathing (steel) for plastering
ASTM C841-81	Installation of interior lathing and furring
ASTM C847-77	Specifications for Metal lath
BSi 1191	Gypsum plaster for building Part I & II
ASTM C-28	Gypsum Plaster
ISO 3048	Gypsum plaster general best conditions
ISO 3049	Gypsum plaster-Determination of physical properties of powder.
ISO 3051	Gypsum plaster-Determination of mechanical properties.
ISO 3052	Gypsum plaster-Determination of water and crystallization.

3 SUBMITTALS

3.1 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.

3.2 Catalogue, data of standard products and printed installation instructions of the ceiling manufacturer shall be submitted for approval of the Engineer well before commencing of works.

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

3.4 The Contractor shall incorporate the required access panels of all types of false ceiling in shop drawings.

4 PRODUCT DELIVERY, STORAGE AND HANDLING

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

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

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.

5 QUALITY ASSURANCE

5.1 Installer Qualifications

Workmen shall be skilled, well trained and experienced in their respective crafts and familiar with specified requirements and methods.

5.2 Manufacturer to be Approved

For hangers, aluminum metal suspension system, panels, air distribution boxes and other accessories the manufacturer shall be the one approved by the Engineer.

5.3 Tolerances

Suspension system components, hangers, fastening devices, supporting light fixtures, metal pan tiles and others shall be so installed that maximum deflection is not more than 1/360th of the span. Allowable tolerance of furnished ceiling system shall be level to within 3 mm in 4m.

5.4 Warranty

Ceiling system materials shall be guaranteed by the manufacturer for 5 years.

6 JOBSITE CONDITIONS

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

6.2 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.

6.3 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.

7 MATERIALS

7.1 SUSPENSION SYSTEM

a) **Suspension System for Acoustic Tiles**

It shall be the Reveal T-Bar system comprising of main T- Bars and Cross T-Bars including the hold down clips for the tiles.

b) **Hangers**

This shall be 8 SWG steel wire or 10 SWG steel bars galvanized to B.S. 443. Attachments and metal accessories shall be provided in accordance with manufacturer's recommendations.

c) **Suspension System for Solid Wood Boards And Sheets False Ceiling**

The Partal wood frame of 2"x1½ @ 1/2x2 both ways shall be screwed to the side walls and suspended with appropriate hanging suspension system to the ceiling as directed by the Engineer.

d) **Metal Lath**

It shall be MS. expanded diamond mesh type conforming to BS 1369 weighing 1.3 Kg/sq. meter. It shall be galvanized to BS 729.

7.2 ACOUSTIC CEILING (Dampa Type)

a) **Acoustic Tiles**

These shall be non-combustible mineral fiber (Select-Tone) reveal tiles. The surface pattern shall be Travertine- Delica or as approved by the Engineer with a dimension of 600 x 600 mm 16 mm thick, all four edges shall be revealed to be installed by an approved recessed suspension system. The tile shall have a factory applied washable white paint finish having a light reflectance of 75 degrees or more.

b) **Acoustic Ceiling**

These shall be 200 mm wide profiled units, manufactured from 0.55 mm aluminum strips. The units shall be perforated and shall have an inlay of pattern glued foil and a pad of mineral wool 12 mm thick. The units shall be chromated and stone enamelled in white and manufactured by Dampa UK or Laxalon Sadi or approved equivalent.

7.3 WOODEN CEILING

a) **Wood**

It shall be best quality available wood as specified on the drawing.

b) **Chip Board and MDF Board**

It shall be of best quality available having uniform texture and thickness. The density of the chip board and MDF Board shall be in the range of 800 Kg per cu.metre.

c) **Fiber Insulation Board**

It shall be 2 inch (50 mm) thick high density rigid panel and shall have high sound absorption efficiency as manufactured by Ownens Corning. Fiber glass Corporation U.S.A. or any other approved manufacturer.

7.4 PLASTER OF PARIS

Plaster of Paris tiles/panels shall be made of calcium sulphate hemihydrate and it shall conform to BS 1191. Most of the panels shall be reinforced with hesssian cloth. The special panels which have long span shall be reinforced with BRC Wire mesh D-83.

The Contractor shall use rubber/rubber lined mold for casting the specified size of Plaster of Paris tiles/panels.

Materials shall conform to the applicable provisions of BS-CP 29.

7.5 SHEET FALSE CEILING

The asbestos cement sheet hard board or other sheets for false ceiling shall be of the approved pattern, size and thickness.

8 EXECUTION

8.1 GENERAL REQUIREMENTS

a) False ceiling shall be installed wherever indicated on the Drawings.

b) Temperature shall be maintained at 10 degrees centigrade or above while system is being installed.

c) Application of ceiling units shall be done in strict accordance with the manufacturer's specifications unless otherwise modified.

d) Ceiling units shall be Installed in a true and even plane, in straight line, courses laid out symmetrically about centre lines of ceiling or panels.

e) Reinforcement shall be provided around openings of electrical lighting, air diffusers and access panels as indicated and shown on the Drawings.

f) Reinforced bracing for hanger bolts shall be provided where the height of space in ceiling is more than 1.5 metres.

g) Anti-corrosive paint shall be provided at welding points.

h) Access panels shall be furnished and installed as shown on the Drawings in strict accordance with the manufacturer's specifications.

8.2 INSTALLATION OF ACOUSTIC TILES AND CEILING

False ceiling suspension system and panels shall be installed in accordance with the requirements of BS-CP.290 and with the manufacturer's recommendations as approved by the Engineer. Engineer shall be notified of any discrepancies which preclude installation in patterns shown prior to execution of Work.

a) The hangers as specified shall be evenly disposed as per Shop Drawings and placed in position as indicated at the time of concrete pour of R.C.C. roofing structure. Their lengths clear of roofing slab shall be as per Shop Drawing.

b) The framing shall be of the specified section and run at spacings as per Shop Drawings. The jointing of battens to hangers and the extra framing if required shall be provided for light receptacles/air- conditioning as per approved Shop Drawings.

c) Wall angles shall be positively and rigidly connected to the structure and to cross runners.

d) Tiles shall be installed in the grid system after completion of installation of the suspension, lighting fixtures and ventilating unit.

e) 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 approved Shop Drawings.

8.3 INSTALLATION OF WOODEN & FIBER BOARDS FALSE CEILING

a) **Wooden**

The Partal wood frame of 2"x1 ½ @ 2' x 2' both ways shall be screwed to the side walls and suspended with appropriate hanging suspension system to the ceiling. The MDF Board of specified thickness as shown on the Drawings shall be screwed to the wooden frame. The deodar wood strips 2" x ½ " thick of specified length shall be then glued to MDF board by approved adhesive and nailed with headless nails and polished/painted as directed by the Engineer.

b) **Fiber Boards**

Chip Board panels of size shown on the Drawings shall be first screwed to the wooden structure provided for the ceiling. Fiber glass insulation board shall then be glued to the chip board by an approved adhesive. Adhesive shall be applied around the panel perimeter using a minimum of 10 mm dia bead of adhesive and a maximum of 300 mm length wise.

8.4 PLASTER OF PARIS

600x600x25mm plain or patterned plaster of Paris tiles equally and proportionally divided with joint and groves as per approved drawing shall be screwed with wooden frame. The plaster of Paris cornice tiles with approved pattern design and groves shall also screwed to wood framing and walls. The groves in panel and cornice shall be painted with two coats of golden lacquered or as approved by the Engineer.

8.5 METAL LATH PLASTER CEILING

Metal lath plaster ceiling shall consist of expanded galvanized metal lath suspended to an approved framing system consisting of main runners and cross runners of steel channels, bars, clips or other devices as approved by the Engineer.

15mm thick cement sand plaster in the mortar ratio of 1:4 shall be applied smooth over metal lath to completely cover both internal and external surfaces of the metal lath. Ceiling shall be applied with two coats of approved paint and finished fine, smooth to the acceptance of the Engineer.

9 INSTRUCTIONS

a) Light fixtures and ventilating units shall be installed in grid pattern shown and supported in accordance with the manufacturer's recommendations.

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

c) The panels which are damaged or improperly installed shall be removed and replaced by the Contractor at his own cost.

10 MEASUREMENT AND PAYMENT

10.1 General

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

- G.I. hanging system, M.S. strip hangers and anchor bolts, steel channels, bars, clips etc.
- Partal wood framing.
- MDF Board
- Polishing/Painting to false ceiling.
- Deodar wooden strips.
- Provision of extra framing for light points, columns etc.
- Headless nails and adhesive

10.2 False Ceiling

10.2.1 Measurement

Measurement of acceptably completed works of false ceiling will be made on the basis of net actual area in square feet of false ceiling provided and installed in position as shown on the Drawings or as directed by the Engineer.

10.2.2 Payment

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

FLOOR AND WALL FINISHES

1 SCOPE

The work done under this section of the Specification consists of furnishing all plant, labor, equipment, appliances and materials and performing all operations in connection with the installation of cement concrete floors and floor finishes including bases, skirting wainscots and exterior wall finishes 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 specifications is covered with detailed specifications as laid down herein.

2 APPLICABLE STANDARDS

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

Pakistan Standard

232 Ordinary Portland Cement

511 Terrazzo tiles

531 Cement Concrete Floor Tiles

ISO (International Organization for Standardization

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

R 681 Chemical analysis of cements Minor constituents of Portland cement.

ASTM (American Society for Testing and Materials)

C 482 Bond strength of ceramic tile to Portland cement.

C 648 Breaking strength of ceramic tile.

C 650 Resistance of ceramic tile to chemical substances.

C 798 Color permanency of glazed ceramic tile.

D 2859 Flammability of finished materials vinyl-asbestos tile or flooring.

D 3564 Application of floor polishes to maintain vinyl- asbestos tile or flooring.

E 84 Surface burning characteristics of building materials

F 141 Resilient floor coverings, definitions of terms.

F 510 Resistance to abrasion of resilient floor coverings.

BSI (British Standards Institutions)

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

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

1201Pt.2	Aggregates for granulithic concrete floor finishes.
1281	Glazed ceramic tiles and tile fittings for internal walls.
1286	Clay tiles for flooring
3260	PVC (vinyl) asbestos floor tiles.
3261	Unpacked flexible PVC flooring.
5385	Internal Ceramic wall tilling and mosaics in normal conditions.
5442	Classification of adhesives for use in Construction pt-1 Adhesives for use.
203	Sheet and Tile flooring
204	In-situ Floor Finishes.
209 Pt.1	Care and Maintenance of floor surface, wooden flooring.

3 SUBMITTALS

Prior to the execution of work and sufficiently in advance, the Contractor shall submit to the Engineer:

3.1 Methodology

Method statements detailing his proposed plans and program in respect of all the important and critical items of work or parts thereof for technical scrutiny. He should obtain approval from the Engineer in time so that the Work schedule is not affected adversely.

3.2 Specimen Samples

Specimen samples of all the materials, elements, components and embedded parts (if any) for prior approval by the Engineer. The Contractor shall retain and store the approved samples throughout the entire period of Works. Three samples shall be submitted of each type of all available Color and pattern for approval.

3.3 Technical Literature

Technical literature, brochures and documents relevant to the items of Works and the materials or components that he intends to use in the Works. The literature shall include manufacturers/supplier's specifications/ recommendations.

3.4 Test Certificates

Test Certificates in respect of the materials/products from the manufacturers/suppliers. In case of supplies, the Contractor shall ensure that the materials supplied are from genuine source and from the original manufacturers.

4 TOLERANCES

The tolerance in surface level of terrazzo and ceramic tiles shall be 1/8” (3mm) over a length of 10 feet (2 meters).

5 TESTING

5.1 **Tiles**

The Contractor shall provide samples of tiles for selection, testing and approval of the Engineer. The samples shall be in finished sizes and shapes and adequate in number for testing in the laboratory as and when ordered by the Engineer.

The Contractor may also be required to lay samples of finished items of tile work fixed in position before he is allowed to proceed with the work on a particular item.

5.2 **Adhesion to Base**

The adhesion between the screed or topping and base of tile shall be tested by tapping the surface with a rod or a hammer. A hollow sound shall be considered to indicate poor adhesion. When poor adhesion is accompanied by visible or measurable lifting of tiles at the edges of bays or the tile cracks then the adhesion shall be considered to be unsatisfactory and it shall be necessary to renew the whole of the affected bay or bays.

6 DELIVERY AND STORAGE

6.1 Materials shall be delivered in manufacturer's original sealed containers with labels intact and legible, identifying brand name and contents.

6.2 Manufactured materials shall be protected from moisture and extreme of heat and cold.

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

6.4 There shall be a physical partition between the stockpiles of coarse and fine aggregate.

7 MATERIAL

7.1 **Gray/ White Cement**

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

7.2 **Sand**

All fine sand shall be obtained from sources approved by the Engineer. The grading shall conform to B.S 882 Grading Zone 1 and 2 of which the gradation limits are as follows:

Percentage (by weight) passing

Sieve	Grading Zone 1	Grading Zone 2
3/8" (9.53mm)	100	100
3/16” (4.76mm)	90-100	90-100
No. 7	60- 95	75-100
No. 14	30- 70	55- 90
No. 25	15- 34	35- 59

No. 52	5- 20	8- 30
No. 100	0- 10	0- 10

7.3 **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 BSS NO.882 and shall be graded as follows:

Sieve	**% Passing by weight**
25.40mm (1")	100
19mm (3/4")	90-100
9mm (3/8")	20- 55
4.67mm (3/16")	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 and 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 with-out delay.

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

7.4 **Brick Ballast** :

Brick Ballast as Sub base of floors shall be obtained from well burnt or over burnt bricks which are hard, durable and strong. Brick ballast shall be free from impurities, quarry sap, dust, dirt and solubility characteristics

7.5 **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.

7.6 **Terrazzo Tiles**

Terrazzo tiles shall be first grade mechanically compressed type conforming to PS-531. Tiles shall be of sizes specified on the drawings with a topping of ½" (10mm) thickness composed of 1:2 cement marble chips, the base being 1:2

cement mortar. The Color quality and size of chips and Color of cement shall be as per approved sample.

7.7 **Ceramic Tiles (Glazed , Matt tiles)**

Ceramic tiles shall be export quality white or Colored. The size, Color pattern and shade of Ceramic tiles shall be selected and approved by the Engineer, and shall conform to BS 1281 as per samples.

7.8 **Cleaning Compound**

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

7.9 **Division Floor Strips**

7.9.1 **Glass Floor Division Strips**

Division strips of glass shall be cut from 5mm thick plate glass in widths as specified in the drawings or as directed by the Engineer.

7.9.2 **Brass or Aluminum Floor Division Strips**

Floor dividing strips of brass and aluminum shall be at least 1/8 inch (3 mm) thick and 1½ inch (38 mm) wide or as required in the drawings

7.9.3 **Marble Floor Division Strips**

The marble dividing strips shall be ½ inch (12mm) thick and 1½ inch (38 mm) wide or as directed by the Engineer.

Pigment and Joint Filler

7.9.4 The mineral pigment for coloring the matrix of terrazzo shall be of the best quality, purity and shall be alkali resistant, sun proof and lime proof with a specific gravity similar to that of Portland cement.

7.9.5 Joint filler shall be white Portland cement grout which shall bond to dry tile, shall be non- shrinking, stain resistant, permanent in Color and shall not in habit fungus and bacterial growth. It shall be odorless and non-toxic, of smooth consistency for early preparation and neat rapid installation and shall contain non-metallic material. Grout shall be water resistant and shall not wash out under water.

7.9.6 Commercial product for polish shall be of the best quality as approved by the Engineer.

7.10 **Marble Chips**

Marble chips shall be crushed marble of specified grade and Color shall be of approved quality from quarries in Pakistan. It shall have an abrasive hardness of not less than 16. Before any material is purchased, the contractor shall submit to the Engineer for approval samples in duplicate. The material used in the work shall correspond with the approved samples in quality, Color texture and finishes etc.

7.11 **Precast concrete interlock Pavers**

The type, Color, pattern and shade of Pavers shall be selected and approved by the Engineer The minimum compressive strength of interlock paver shall be 7000psi.as approved by the Engineer.

7.12 The pre cast cement concrete tiles (clad stone) for the floors and walls shall be from the approved manufacturers.

The size, Color, shade and patterns shall be as shown on the drawings and as approved by the Engineer.

8 EXECUTION

8.1 CEMENT CONCRETE FLOORING

The materials for P.C.C flooring shall be same as already specified under clause 7, **"Materials"**.

8.1.1 Preparation

The ground surface shall be cleared and grubbed of top soil and all grass, roots and loose material removed in any. Surface shall be dry, levelled and any fill or backfill under the floors done as per section Earth work Sub-Section 6 of these Specifications.

8.1.2 Sub-Base

The floor sub base shall be either brick ballast or lean concrete or R.C.C Slab as shown in the drawings.

8.1.2.1 Brick Ballast

The brick ballast shall be of 1:6:12 using coarse aggregate as brick ballast and laid in position. It shall be properly watered and rammed to get the required thickness.

8.1.2.2 Lean Concrete

Lean concrete shall have a strength of 1000psi. and shall conform to Section Plain and Reinforced Concrete of these Specifications. It will be screed in position to required depth and or surface elevations.

The surface of the sub base concrete shall be brushed with a stiff broom just before it hardened to remove all litanies and loose aggregate and at the same time to roughen the surface to improve the bond. The hardened base shall be thoroughly cleaned, wetted preferably overnight, the surplus water removed and a grout of cement and water brushed into the surface just ahead of the application of the topping.

8.1.3 Panels

Before laying the cement concrete flooring, the surface of the sub-base shall be divided into panels of required size as shown on the Drawings. Panels shall be made of plate glass, division strips or as specified. The top of the division strips shall conform to the specified level of the finished floor surface.

8.1.4 **Floor**

Mixing and placing of first bottom layer of 3000psi. concrete shall be in accordance with **Section 2300-"Plain and Reinforced concrete".** Concrete may be conveyed in any suitable manner from the place of mixing provided there is no segregation or loss of any ingredients and provided it is placed in its final position before initial setting takes place, that is within 30 minutes of addition of water to the mix. The concrete will be laid in a manner so as not to cause the aggregate to separate from the mortar and laid in alternate panels, each panel shall not exceed the area as directed by the Engineer. Dividing strips shall be providded unless otherwise specified on the Drawings and BOQ. The floor concrete panels shall have the thickness as shown on the Drawings. The concrete shall be rammed and thoroughly consolidated and finished rough.

8.1.5 **Finishing**

Immediately after consolidation, the surface, shall be levelled with a wooden trowel. Excessive trowelling in the early stage shall be avoided. The surface shall be tested with a straight edge to detect undulations, which, if found, shall be eliminated. The finer components in the concrete which come to the surface with the stroking shall be quickly but carefully smoothed with the steel trowel. When the concrete has hardened sufficiently, trowelling shall be done with steel trowels. No dry cement or a mixture of dry cement with sand shall be sprinkled on the surface for hardening the surface.

8.1.6 **Dado/Skirting**

The plaster on the portion of the wall to be provided with skirting or dado shall be left in a rough state by brooming or by using wire brushes of approved type so as to provide a bond between this base plaster and the dado or skirting. The surface of the wall shall be cleaned of all foreign matter and shall be thoroughly wetted to control the suction. Only so much mix shall be mixed with water that could be utilized within 30 minutes. This mix of cement and coarse sand in the ratio of 1:2 shall be applied to the wall in a thickness as specified and trowelled hard to a smooth surface, proper in line both vertical and horizontal.

8.1.7 **Curing**

Curing shall be carried out in accordance with the Specifications given under Section - Plain and Reinforced Concrete.

INSTALLATION OF TILE FLOORING

The base in cement concrete and if required the sub-base in lean concrete shall be prepared as provided in Sub-Section 8.1 "Cement Concrete flooring". The thickness of sub-base if any and base shall be as shown in the Drawings, BOQ or directed by the Engineer. The surface of concrete base shall be rough finished. The curing period of base shall be at least 72 hours before laying the tile work.

8.1.8 General

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

The Tiles shall be laid to the required levels and grades over a setting bed of ¾" thick cement sand screed comprising of one part cement to three part of sand of volume unless otherwise shown in the Drawings or specified in the BOQ. As large an area of setting bed shall be spread at one time as can be covered with tiles before the mortar has set. Surplus mortar shall be removed. The thickness of setting bed in any space shall not be less than ½" or as shown on the drawings.

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

After each piece is laid, it shall be firmly pressed into place so as to embed it and to even the surface before the mortar takes its initial sating.

Joints between the tiles shall be of uniform width and shall be grouted full with a plastic mix of grey or white cement (as directed by the Engieer) immediately after a suitable area of tiles has been set.

8.1.9 Terrazzo Tiles

The terrazzo tiles will be laid to the required lines, levels and grades over a setting bed of ¾ inch thick cement sand mortar. The thickness of cement concrete subbase and base shall be as per Bill of Quantities.

After seven days of tile laying, the terrazzo tile floors shall be machine grinded to a true even surface using various grades of abrasive stones, as required and directed by the Engineer. After the first grinding the floor shall be grouted with cement mortar of the same Color composition as used for its manufacture. The grout shall be of the consistency of thick cream and shall be brushed over the floor to fill in the joints and after 72 hours the grouting coat shall be removed by grinding till a smooth and even surface is obtained. Areas and portion of the floor inaccessible for

the grinding machine shall be grinded and rubbed by hand. After the floor has been machine finished, it should be covered with white, non-staining sand or rags to protect it while other work is being done. After removal, the floor shall be thoroughly scrubbed. The final gloss shall be given by chemical polishing the surface to the satisfaction of the Engineer. Preservative treatment for terrazzo floor shall produce a water-proof finish which will not be impaired by immersion in water at room temperature for a period of 2.5 hours, approximately 18 hours after the floor is finished by buffing, as specified. The preservative material shall not disColor the buffing, as specified the terrazzo nor leave a tacky or sticky finished film on the surface after buffing.

8.1.10 **Ceramic Tiles**

The glazed and matt finished ceramic tiles shall be laid to the required lines, levels and grades over a setting bed of cement sand mortar comprising of one part of cement and 3 parts of sand by volume and the joints filled with neat white cement mixing with matching Color pigment including vertical and horizontal covers. The tile floor/wall shall be kept wet for at least 72 hours and no traffic should be allowed on the tiles during curing period.

8.2 TERRAZZO CAST IN-SITU

8.2.1 FLOORING

8.2.1.1 Mix

The terrazzo mixes shall be composed by volume as follows:

8.2.1.1.1 Plain terrazzo for all floors and basis indicated as terrazzo and not otherwise specified, shall be composed of one part cement (white or gray) and 2 parts of marble chips of the sizes Colors and pigment as shown on the Drawings specified in BOQ specified and/or as directed by the Engineer.

8.2.1.2 Preparation for Terrazzo

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

8.2.1.3 Division Strips

The under bed consisting of 3000 psi. concrete screed shall be spread and brought to a level not less than ½ inch (15mm) below the finished floor level, the dividing strips shall be installed in the green under bed.

Terrazzo floors under bed shall be divided by marble/glass, aluminum/brass strips as specified and approved by the Engineer. The division strips between field work and borders shall have exposed tops in full width of the strips. The strips being partially embedded therein, securely anchored to the under bed and grouted solid.

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

Unless otherwise shown on the drawings, the divisions in field work of large areas shall not exceed 3ft x 3ft and in small areas shall not exceed 2ft x 2 ft

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

8.2.1.4 **Laying Terrazzo**

The sub-surface shall be swept clean, thoroughly moistened, but not saturated, and slushed with a coating of neat cement grout approximately 1/8 inch (3 mm) in thickness. The under bed consisting of 3000 psi. Concrete screed shall be spread and brought to a level not less than ½ Inch (15mm) below the finished floor level, the dividing strips shall be installed in the green underbid. The cement and marble must be mixed dry in such quantities as are sufficient for a unit of specified shade. Water shall be added to only such quantities as can be mixed thoroughly and consumed in less than 30 minutes, the quantity of water being the minimum for workability. Mixing must be done on water tight platform and any mix not used within 30 minutes shall be discarded and removed from the Site. A layer of cement and marble chipping mixture should be well trowelled into the surface of the base concrete before filling to the top level of the screeds. The layer should be well compacted and all voids shall be filled in. A layer of neat cement, of the specified Color shall then be well trowelled into the surface leaving a plain smooth surface.

8.2.1.5 **Seasoning**

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

8.2.1.6 **Surface**

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

8.2.1.7 **Finishing**

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

8.2.2 **Terrazzo Dado and Skirting**

The plastered surface over which the dado/skirting is to be applied shall be well roughened and watered, cement mortar of specified ratio shall then be plastered over this well roughened surface to the indicated thickness. Before the base course has set the layer of terrazzo mixture shall be well trowelled into the surface of the base to a thickness which after grinding shall result in the finished thickness. A layer of neat cement of the specified Color shall then be well trowelled into the surface leaving a plain smooth surface. After the period specified for floors above, the Contractor shall start finishing as for floors specified above. Terrazzo skirting shall be provided around all terrazzo floors unless shown otherwise. Skirting and dado shall be straight, level and in plumb. Intersections at floors shall be straight and flush.

8.2.3 **Terrazzo on Stairs**

The stair risers and treads shall be provided in 3000 psi. Concrete according to exact sizes including the terrazzo topping making allowance for grinding of terrazzo. The nosing shall be flush with the terrazzo toppings, and shall be protected by aluminum angles as specified or shown on the Drawings. The angles shall be firmly secured, by means of counter-sunk brass screws, and cast together with the step.

8.2.4 **Washed Terrazzo On Walls**

The work to be done by the contractor consists of providing ¾" thick washed terrazzo in white cement with approved pigment, laid on ½" rough plaster in 1:3 cement sand mortar in panels with ¾"x ¾" thick Aluminum "U" channel on walls, and other surface as shown on the Drawings.

8.2.4.1 **Sub Grade**

The sub grade under terrazzo top shall be ½ thick cement sand rough plaster in 1:3. The sub grade shall be constructed in accordance with the applicable stipulations and requirements of section Cement Plaster of these specifications. The sub grade surface be kept wet for proper adhesion of terrazzo topping, which shall be laid when the sub grade is still green.

8.2.4.2 **Topping**

The terrazzo topping shall consist of one part of white cement and one and half parts of marble chips mixed by volume with approved water cement ratio. The dividing panels of Aluminum "U" section shall be fixed with stainless streel or brass screw in the size as directed by the Engineer. Before laying terrazzo topping the surface shall be thoroughly cleaned so as to be free from dust or foreign matter. The topping shall be laid while the bottom sub grade surface is still plastic preferably the next day, after the sub grade is laid if the surface is not plastic a slurry of neat cement shall be brushed on to it immediately before the topping is laid.

8.2.4.3 Rough Finish

Before the terrazzo is hardened the top surface shall be brushed down, plenty of water being used in this process. The brushing shall continue till the matrix is removed and each piece of marble chips is clearly exposed. If brushing of surface does not produce desired results tooling process shall be carried out by Kango Hammer. After whole of the area is evenly exposed the surface shall be sprayed with water and lightly brushed down cleaning all the adhering mortar and revealing the true Color on the marble chips.

8.3 Protection

All surfaces of the finished work of other trades shall be properly protected from damage and spoiling during the process of grinding and washing of the terrazzo.

After the final grinding has been completed and the surface treatment and polish applied, the terrazzo work shall be covered and protected with material approved by the Engineer until completion of the work of all other trades.

8.4 Cleaning and Coating

Prior to placing the protective covering, the terrazzo floor shall be approved by the Engineer. After the work of all other trades has been completed and the protective covering removed, all terrazzo work shall be washed with cleaning compound, mixed with water and using a fine abrasive where necessary to remove any stains or cement smears. The terrazzo shall be allowed to dry

thoroughly and shall be given a sealing application of preservative material. The sealing material shall be applied in accordance with the manufacturer's directions, leaving all terrazzo work in clean condition as approved by the Engineer. The final glass shall be given by polishing with chemical polish the surface, with was polish of approved manufacturer, to the satisfaction of the Engineer.

8.5 PRE CAST CONCRETE INTERLOCK PAVERS

The pre-cast interlock concrete pavers of specified size, shape and Color shall be laid to the required lines, levels and grades over a well compacted setting bed of 100mm thick sand mixed with 37mm down crushed stone over 50mm thick sand cushion. The joints between the paver shall be filled with neat sand.

The laid paver shall be compacted with the compactor as specified by the Manufactures. Care shall be taken that full pavers are used as far as possible. Where this is not possible, the edge pavers shall be neatly cut with an electric saw and the edges rubbed smooth, in case of patterned pavers, the pavers shall be laid in such a way that the pattern ends symmetrically on two sides.

8.6 PRE CAST CEMENT CONCRETE TILES ON FLOOR AND WALLS

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

The Tiles shall be laid to the required levels and grades over a setting bed of ¾" thick cement sand screed comprising of one part cement to three part of sand of volume unless otherwise shown in the Drawings or specified in the Bill of Quantities. As large an area of setting bed shall be spread at one time as can be covered with tiles before the mortar has set. Surplus mortar shall be removed. The thickness of setting bed in any space shall not be less than ½" or as shown on the drawings.

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

After each piece is laid, it shall be firmly pressed into place so as to embed it and to even the surface before the mortar takes its initial sating.

Joints between the tiles shall be of uniform width and shall be grouted full with a plastic mix of neat grey or white cement (as directed by the Engineer) immediately after a suitable area of tiles has been set.

9 MEASUREMENT AND PAYMENT

9.1 General

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

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

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

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

9.1.3 1:3 cement sand setting mortar.

9.1.4 Finishing, washing and polishing works of ceramic tiles and washed terrazzo on wall..

9.1.5 Rough plaster and Cement sand mortar as Adhesive for fixing of tiles.

9.1.6 Any steel sec. for fixing of tiles on wall.

9.1.7 6 Inch (100 mm) thick Setting bed of crushed stone and 2 inch (50 mm) thick sand for interlock pavers.

9.1.8 Providing & fixing of specified dividing strips for cast in situ terrazzo.

9.1.9 3000 psi. cement concrete as base for terrazzo or any type of floor. .

9.1.10 Color Pigment.

9.1.11 Aluminum “U” channel and ½ inch (12mm) thick rough plaster for Washed terrazzo on wall.

9.2 Tiles on floor

9.2.1 Measurement

Measurement of acceptably completed works of respective type of tile on floor will be made on the basis of net actual area in square feet of floor laid in position to the line, level & grade as shown on the Drawing or as directed by the Engineer.

9.2.2 Payment

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

9.3 Tiles on walls

9.3.1 Measurement

Measurement of acceptably completed works of respective type of tiles in dado and on wall will be made on the basis of net actual area in square feet laid in position to the line, level & grade as shown on the Drawing and as directed by the Engineer.

9.3.2 Payment

Payment will be made for acceptable measured quantity of respective type of tile in dado and on walls on the basis of unit rate per square feet quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the items.

9.4 Terrazzo Skirting/Dado

9.4.1 Measurement

Measurement of acceptably completed works of Terrazzo skirting/ dado will be made on the basis of net actual area in square feet laid in position to the line, level & grade as shown on the Drawing and as directed by the Engineer.

9.4.2 Payment

Payment will be made for acceptable measured quantity of Terrazzo skirting/dado on the basis of unit rate per square feet quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the items.

9.5 Terrazzo Cast-in-situ Floor

9.5.1 Measurement

Measurement of acceptably completed works of Terrazzo Cast-in-situ floor will be made on the basis of net actual area in square feet of floor laid in position to the line, level & grade as shown on the Drawing or as directed by the Engineer.

9.5.2 Payment

Payment will be made for acceptable measured of Terrazzo Cast-in-situ floor on the basis of unit rate per feet quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

9.6 Terrazzo Tiles.

9.6.1 Measurement

Measurement of acceptably completed works of Terrazzo Tiles on floor will be made on the basis of net actual area in square feet of floor laid in position to the line, level & grade as shown on the Drawing or as directed by the Engineer.

9.6.2 Payment

Payment will be made for acceptable measured of Terrazzo Tiles floor on the basis of unit rate per feet quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

9.7 P.C.C Floor

9.7.1 Measurement

Measurement of acceptably completed works of P.C.C floor will be made on the basis of net actual area in square feet of floor laid in position to the line, level & grade as shown on the Drawing or as directed by the Engineer.

9.7.2 Payment

Payment will be made for acceptably measured quantities of P.C.C floor will be made on the basis of unit rate per Sq.feet quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

9.8 Washed Terrazzo on walls

9.8.1 Measurement

Measurement of acceptably completed works of washed terrazzo on walls will be made on the basis of net actual area in square feet, laid in position to the line & level as shown on the Drawing or as directed by the Engineer.

9.8.2 Payment

Payment will be made for acceptably measured quantities of washed terrazo will be made on the basis of unit rate per Sq.feet quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

9.9 Ceramic Tile Decorative Border

9.9.1 Measurement

Measurement of acceptably completed works of Ceramic Tile Decorative Border on walls will be made on the basis of net actual Length in running feet, laid in position to the line & level as shown on the Drawing or as directed by the Engineer.

9.9.2 Payment

Payment will be made for acceptably measured quantities of Ceramic Tile Decorative Border will be made on the basis of unit rate per running feet quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

GENERAL INSTRUCTION

1. All wood work to be properly seasoned and of 'A' quality.

2. M.D.F. board to be of Lasani (Gold grade) or approved equivalent,

3. Steel reinforcement and cement (Grey & White) to be used as approved.

4. Formica to be of Baluchistan Laminates or approved equivalent.

5. All polish on wood work to be imported stain as approved in Matt / Satin Finish with required of coats of ICI or approved equivalent polyurethane as per manufacturer's specification and instruction.

6. All wooden frame work to be solignum treated (English make) prices to be included in respective items of BOQ.

7. All materials specified like wood, MDF board, M.S. & Stainless Steel, PVC & S.S Skirting, Glazing, etc. mentioned in nomenclature / drawings to be used in maximum possible sizes to avoid too many joints, etc.

8. All hardware like, hinges, Jacks, catchers, handles, etc. to be used of best quality as per hardware schedule and instruction of the Architect.

9. Ali aluminum section to be of Pakistan Cable or approved equivalent.

10. All Glass to be imported of China origin or approved equivalent.

11. All paint Matt Enamel Primer, Anti Corrosive, etc. to be of ICI or Bergen

12. All M.S. work to be treated with minimum 2 coats of Anti Corrosive paint.

13. All material specified must be approved by Architect before installation.

GENERAL SPECIFICATION OF FURNITURE

1. **Wood**:

   Wood of any kind, seasoned having 7 - 8% moisture

2. **Lamination Board**

   12mm – 20mm thick high density chipboard pressed with Formica (Baluchistan Laminates or equivalent) on both sides, edge covered with PVC edging of matching color.

3. **Screws**

   Adamjee or Equivalent

   Wooden - 1 ½" – 2 ½" x 10 counter sunk

   Steel - ¼" – 2" x 8

4. **Steel Pipe**

   Mild steel sq. pipe wall thickness 1-2 mm / 18 gage pipe (mild steel / cold rolled IIL Karachi or equivalent)

5. **Rubber Shoes**

   All furniture shall be fixed with rubber shoes.

Technical Specifications of
Modular Straight Frame System

1. **Sign Structure**:

   1.1 Imported Plastic Coated MS Sheet Background holding the side structure

   1.2 Imported Double Adhesive for Joinery

   1.3 Aluminum Alloy Sliding Structure S-12 Hollow section with 20 Micron Anodizing

   1.4 Plastic Hard Solid imported ABS End Caps

   1.5 SS Screws Philips C'Sunk Self Tapping Screws

   1.6 Drilled and Screwed on Walls with rawl plugs / DA material

2. **Upper Module**:

   2.1 Aluminum Alloy Strips I-25 with reversible face and 20 Micron Anodizing

   2.2 High Quality Digitally printed PVC with Metallic Silver Logo and Scratch Resistant Laminated & UV Protection

3. **Main Module**:

   3.1 Aluminum Foiled Panel Main Module C-95

   3.2 Aluminum Alloy L-50 Modules over and beneath the Main Module

   3.3 High Quality Vinyl Digital Printing with Scratch Resistant Lamination & UV Protection

4. **Lower Module**:

   4.1 Aluminum Alloy Strips I-25 with 20 Micron Anodizing

   4.2 High Quality Digitally printed PVC with Metallic Silver Logo and Scratch Resistant Laminated & UV Protection

APPROVED LIST OF MANUFACTURES / SUPPLIERS

1. **Paint**
   - Kansai, Nippon, Jotun
2. **Polish**
   - ICI, Nippon, Jotun
3. **Fabric**
   - Fabric Project, Islamabad
   - Karachi Interior, Blue Area Islamabad
   - Selection Interior, Blue Area, Islamabad
4. **Furniture**
   - Decent Furniture, Rawalpindi
   - Inter Wood Model Pvt Limited, Islamabad
   - Enem Furniture, Islamabad
5. **M.S Pipe**
   - IIL, Karachi
   - Bashir Pipe, Lahore
6. **Lamination and Formica**
   - Balochistan Laminates, Karachi
   - Al Noor Group, Karachi
7. **Signage**
   - Samad Brothers, Blue Area, Islamabad
   - 3M, Blue Area, Islamabad
8. **Carpet**
   - Pak Carpets, Bank road, Saddar, Rawalpindi
   - Venus Carpets, Saddar, Rawalpindi
   - InterFlor, Islamabad

MEP Works

Technical Specifications

Raahim Associates

Table of Contents

Section 1: General Guidelines

1.1 Description:

The Work shall consist of furnishing and installation of all electrical and allied systems as shown on the drawings as specified herein and as directed by the Engineer.

1.2 Reference Codes & Standards:

Electrical materials and equipment furnished and installed shall comply with internationally recognized standards and codes and those of the Department and Local Project Specific Regulation Authorities Guidelines.

Sr#	Description	Reference Standard	Particular Section
A	Low Voltage Installations		
	General:		
1	Electrical Installations for Buildings	IEC	IEC 60364
2	Requirements for Electrical Installations. IET Wiring Regulations	BS	BS 7671
3	Electricity in Buildings	CIBSE	CIBSE-Guide K
B	Specific:		
B1	Low Voltage Distribution System		
5	Transformers	IEC	IEC-60076
6	Genset	ISO, NEMA, IEC, UL, NFPA	ISO 8528, IEC 34-1, NEMA MG-1-1, CSA 22, 282, UL 2200
7	Low-voltage switchgear and Control gear assemblies (Circuit-breakers, Switches, disconnectors, switch-disconnectors and fuse-combination units, Contactors and motor-starters - Electromechanical contactors and motor-starter, Multiple function equipment - Transfer switching equipment, distribution boards)	IEC	IEC 60947-1 IEC- 61439
8	Busbar Trunking System	IEC	IEC- 61439

9	Residual current operated protective devices	IEC	IEC 60755
10	Degrees of protection provided by enclosures (IP code)	IEC	IEC 60529
11	Switch Sockets	IEC	IEC60309, BS 546,1363
B2	**Earthing, Lightning Protection & Surge Protective Devices**		
12	Lightning Protection	NFPA, IEC	NFPA-780 IEC-62305
13	Earthing	IEEE	IEEE-80
14	Surge Protective Devices	IEC	IEC-62305,61643
B3	**Extra Low Voltage System**		
15	Fire Alarm System	NFPA, BS	NFPA-72 BS-5839
16	Public Evacuation System	BS	BS-5839
B4	**Lighting**		
17	Lighting	SLL (Society of Light & Lighting), OSHA,	SLL Code for Lighting (2012), OSHA, IESNA
B5	**Telecommunications**		
18	Telecommunications	ANSI/TIA, EN	ANSI/TIA-568-C, EN-50173
C	**Medium Voltage Installations**		
19	Short-circuit currents in three-phase AC systems	IEC	IEC-60909
20	Instrument transformers	IEC	IEC 61869-1
21	High-voltage switchgear and control gear	IEC, WAPDA	IEC 62271-1 DDS-P44:96
22	Medium Voltage Cables (XLPE)	IEC	IEC-60502-2
23	Lifts/Elevator Standards	EN, EU Lifts Directive	EN 81-20,81-50
D	**Local Prevailing Standards**		
D1	**Pakistan Building Code**		
D2	**LDA/CDA/MDA/Concern Development Authority Standards, Rules Regulations**		
D3	**WAPDA/NTDC/Concern DISCO Standards**		
D4	**Pakistan Building Code (PEC)**		
D5	**Pakistan Energy Efficiency & Conservation Code**		
D6	**Joint Commission International (JCI) Accreditation Standards for Hospitals**		

Any contradictions between the requirements of two or more such standards or codes pertaining to a particular installation shall be brought to the Engineer's attention by the Contractor prior to placing orders for any cable, equipment or material.

The Contractor shall submit information to the Engineer concerning contradictions and qualifying information. The Engineer will direct the Contractor as to the governing standard or code.

1.3 Submittals:

A. Complete list of materials and equipment proposed for incorporation in the work:

a. List shall include manufacturer's name and material or equipment identification such as styles, types or catalog numbers to permit ready and complete identification.
b. Include complete set of catalogs covering these submittals.
c. If catalog does not indicate compliance with appropriate standard as specified, provide additional certification as to compliance subject to approval of consultant.

B. Shop drawings shall be submitted for equipment as specified by Engineer-Incharge.

C. Samples shall be submitted for all items specified herein for Engineer's approval prior to placing order for procurement.
D. Test Reports, per specified procedures advised by consultant, of equipment shall be submitted before execution of the systems.

1.4 Quality Assurance:

The contractor as per Contract Documents shall be fully responsible for the products under defect liability period, warranty period.

All equipment shall be suitable for altitude/weather/seismic conditions of the Project site.

Section-2: Conduits, Raceways, Cable Trays, Ladders

2.1 Conduits:

a. PVC conduits and fittings used in building installation shall be from high impact rigid PVC complying with BS 4607, BS EN 60423 & BS EN 61386, suitable for use at ambient temperature up to 40 deg Cent. The material shall not soften or suffer structural degradation at a temperature of 70 deg Cent and shall be non-hygroscopic, fire retardant.
b. Steel conduits and fittings shall comply with relevant specifications in BS EN 60423, BS EN 61386 and shall be hot dip galvanized to class 4 protection, both inside and outside. Flexible steel conduits and fittings shall comply with BS EN 61386.
c. Corrugated flexible pipe should be installed where directed by the consultant.
d. Conduit systems must be designed and installed so as to exclude moisture, dust and dirt. Small drainage holes must be provided at the lowest part of the system to avoid the accumulation of condensed moisture.
e. All conduit expansion couplings used shall be fabricated from material equal to that of the conduit with which the coupling is to be used, having factory installed packing ring and pressure ring to prevent entrance of moisture. All expansion couplings shall be equipped with earthing ring or earthing conductor. PVC conduits shall be provided with copper/brass terminals.
f. Unless indicated otherwise on the drawings, minimum size of conduits for installations shall be 25 mm diameter.
g. All conduit expansion couplings used shall be fabricated from material equal to that of the conduit with which the coupling is to be used, having factory installed packing ring and pressure ring to prevent entrance of moisture. All expansion couplings shall be equipped with earthing ring or earthing conductor.

2.2 Conduit Accessories:

a. 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 (adequate) 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. Each junction box shall be provided with one-piece cover which shall be fitted on the box with chromium plated screws. The physical size of pull boxes shall be in accordance with the wiring regulations to suit the number and size of conduits and conductors.

b. 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. Pull boxes and junction boxes shall be constructed of galvanized steel. Each shall be suitable in all respects for the applications, and complete with screw-on hinged covers with gaskets. All boxes shall have required number of conduit entry holes and earth terminals for connecting E.C.P. 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.

c. All boxes installed in exterior locations, plantrooms, janitor's room, ducts etc., shall be fitted with approved type gaskets to provide a waterproof seal approved type gasket to provide a waterproof seal between box and cover or other item fitted to the box.

d. All boxes other than those on which accessories or any item of equipment is to be mounted, or at which flexible connections are to terminate, shall be provided with internal fixed brass earth terminals

e. 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 prowhite. Bends shall have enlarged ends to receive the conduit without any deduction in the internal diameter of the PVC pipe.

f. All boxes provided as junction boxes where cable joints are specified or permitted, shall be provided with fixed terminal blocks. Such boxes shall be of adequate size to contain the terminal block and sufficient cable to allow neat connections to be made. The terminal blocks shall be fixed to the box by brass screws and shall comprise brass conductor connectors, with brass clamping screws enclosed in porcelain or other heat resisting insulation material which will not distort or otherwise have its properties damaged by temperatures below the highest temperature at which the insulation of any cable connected to it is destroyed.

g. All accessories e.g. boxes, couplings, bends, solid plugs, bushes, reducers, check nuts etc. shall be equal in quality to the specified conduit.

h. Where inspection boxes occur in floor slabs a special cover on the box shall be installed to the satisfaction of the Engineer.

i. The use of looping in box shall be allowed in places where floor slab thickness permits 90-degree bends in conduit.

j. Each outlet box must be suitable in all respects for the application, and complete with securing lugs, knockouts, and where necessary, suitable plaster rings, concrete rings, covers and any other required accessory.

k. Provide blank cover plates for all boxes without wiring devices. Material and cover to the approval of the Engineer.

2.3 Conduit Installation Instructions:

The contractor shall furnish all labor and material for the installation of conduit as required.

a. 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.

b. Under no circumstances shall chassis 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, chassis shall be made with appropriate tools not deeper than required. The conduit shall than be fixed in the chassis 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.

c. The drawings provided with this specification indicate the approximate position only of outlet points and it shall be the Contractor's responsibility to mark out and center on site, the final positions and he shall also be responsible for their accuracy.

d. 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.

e. 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.

f. 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.

The minimum length of inspection / pull boxes, distribution boards and switchboards in an approved manner to the satisfaction of the Engineer without any additional cost to the owner.

g. Conduit runs between two outlets shall not contain more than two quarter bends or one 90-degree bend.

h. All the free ends of conduit shall be solidly plugged till such time as final and proper terminations are made.

i. 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.

j. Multiple runs of conduit shall be arranged symmetrically.

k. Exposed runs of conduit where required shall be firmly held by means of 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.

l. No conduit less than 20mm dia. shall be used for point wiring and 25mm dia. for conduit 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 IEE Regulations

m. The Contractor shall be responsible for obtaining from site and checking from drawings the location of structural steelwork and the positions of holes, steelwork and finishes. No steelwork will be drilled without first obtaining written approval from the Engineer.

n. The Contractor's attention is specially drawn to the necessity for keeping all conduit entirely separate from other piping services as direct connections will not be permitted between the conduits and such pipes, except where earthing is required. Conduit runs shall be determined by the Contractor and agreed by the Engineer that cables installed in any particular run are easily with-drawable.

o. Conduit systems shall be mechanically continuous and water-tight after installation. Conduit shall be installed in such a manner as to ensure against the collection of trapped condensation.

p. Where conduit runs terminate in the boxes, the termination shall be made with flanged couplings as specified for adaptable boxes.

q. Where conduits are specified in floor screeds, the Contractor must carefully check the proposed screed depths at all positions before installing conduits and shall, wherever possible, arrange to cross conduits where there is ample thickness of screed. If at isolated positions, the crossing of conduits in shallow screeds cannot be avoided, arrangements may be made to set the lower conduit into a shallow chase performed in the slab, subject to the agreement of the Engineer.

r. No wiring shall be carried out before the particular section of the conduit installation to be wired is complete to the satisfaction of the Engineer

s. The conduit outlets when installed and before wiring shall be temporarily closed by means of well-fitting wooden plugs, and immediately before cables are drawn in, conduit systems shall be thoroughly swabbed out until they are dry and clean.

t. The metallic conduit shall be properly and tightly screwed between the various lengths and to the boxes to which it runs and terminates, so that the wiring is continuously and effectively protected throughout its entire length. The entire system shall be electrically and mechanically continuous throughout forming a completely bonded system, the whole being efficiently earthed in the supply point.

u. All steel conduits shall be jointed with solid screwed couplings and flanged couplers at DB's.

v. Surface mounted conduits shall be secured (at a maximum interval of 1.2m) by means of space-bar saddles where multiple runs occur. 'Distance' saddles shall be used on individual runs such as down drops to switches and plug points

w. A 2mm galvanized iron draw wire or approved equal shall be left in every conduit which is left by the Contractor for installation of wires and cables. The draw wire shall have a tensile strength not less than 90 kg.

x. No less than 300mm of slack shall be left at each end of the draw wire.

Section-3: Medium Voltage Cables

PART 1 GENERAL

1.01 DESCRIPTION

A. Work Included:

1. Cables and related splices, terminations and accessories for medium voltage electrical distribution systems.

B. Related Work:

1. Drawings and general provisions of the Contract, including General and Supplementary conditions apply to this Section.

1.02 QUALITY ASSURANCE

A. Comply with requirements of Specifications.

B. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.

C. Testing Agency Qualifications: An Independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationality recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the Inter National Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part3.

D. Source Limitations: Obtain cables and accessories through one source from a single manufacturer.

E. Product data: For each type of cable indicated. Include splices and terminations for cables and cables accessories.

F. Qualification data: For Installer.

G. Material certificates: For each cable and accessory type, signed by manufacturers.

H. Source quality-control test reports.

I. Field quality-control test reports.

1.03 PROJECT CONDITIONS

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or other unless permitted under the following conditions and only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of electric service.

2. Do not proceed with interruption of electric service without Architect's written permission.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are limited to, the list of manufacturers provided with BOQ

2.02 CABLES

A. Cable type: Medium Voltage (15 KV)

B. Comply with BS Standards.

C. Conductor: Copper

D. Conductor Strandling: Compact round, concentric lay Class B.

E. Strand Filling: Conductor interstices are filled with impermeable compound.

F. Conductor Insulation: Cross linked polyethylene.

G. Conductor Insulation: Ethylene-Propylene rubber.

1. Voltage Rating: 15KV

2. Insulation Thickness: 133 percent Insulation level.

H. Shielding: Copper tape, helically applied over semi conduction insulation shield.

I. Shielding and jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket.

J. Three conductor cable assembly: Three Insulated, shielded conductors cabled together with ground conductors.

1. Circuit Identification: Color-coded tape (black, red, blue) under the metallic shielding.

K. Cable Armor: Interlocked aluminum applied over cable.

L. Cable Jacket: Chlorosulfonated Pplythylene, CPE.

2.03 SPLICE KITS

A. Connectors and Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.

B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings and configurations of cable conductors. Include all components required for complete splice with detailed instructions.

1. Combination tape and cold shrink rubber sleeve kit with re-jacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.

2. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.

3. Premolded, cold shrink-rubber, in-line splicing kit.

4. Premolded EPDM splicing body kit with cable joint sealed by interference fir of mating parts and cable.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install cable according to IEEE 576.

B. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

1. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.

2. Use pulling means, including fish tape, cable rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.

C. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

D. Install "buried-cable" warning tape 12 inches(305 mm) above cables.

E. In manholes, hand holes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.

F. Install cable splices at pull points and elsewhere as indicated; use standard kits.

G. Install terminations at ends of conductors and seal multi conductor cable ends with standard kits.

H. Install separable insulated connector components as follows:

1. Protective caps: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.

2. Portable Feed – Through Accessory: Three

3. Standoff Insulator: Three

I. Arc Proofing: Unless otherwise indicated, arc proof medium voltage cable at locations not protected by conduit, cable tray, direct burial of termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:

1. Clean cable sheath.

2. Wrap metallic cable components with 10-mil (250-micrometer) pipe-wrapping tape.

3. Smooth surface contours with electrical insulation putty.

4. Apply arc proofing tape in one half-lapped layer with coated side toward cable.

5. Band arc-proofing tape with 1 inch (25 mm) wide bands of half-lapped adhesive, glass cloth tape 2 inches (50 mm) o.c.

J. Install fault indicators on each phase where indicated.

K. Ground shields of shielded cable at terminations, splices and separable insulated connectors, Ground metal bodies of terminators, splices, cables and separable insulated connector fittings and hardware.

3.02 FIELD QUALITY CONTROL

A. Testing: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports.

B. Perform the following field test and inspections and prepare test reports:

1. Perform each visual and mechanical inspection and electrical test stated in BS. Certify complains with test parameters.

2. After installing medium voltage cables and before electrical circuitry has been energized, test for compliance with requirements.

C. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

Section-4: Low Voltage Power Cables

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 DESCRIPTION OF WORK:

A. Work Included: Provide low voltage electrical conductor, cable, wire, and connector work as shown, scheduled, indicated, and as specified.

B. Types: The types of low voltage electrical conductor, cables, wire, and connectors required for the project include, but are not limited to, the following:

1. 600/1000 volt building wire and cable.
2. 600/1000 volt building wire and cable connectors.
3. 300/500 volt control/signal wire and cable.
4. 300/500 volt control/signal wire and cable connectors.

C. Application: The applications for cable, wire, and connectors required on the project are as follows:

1. Power distribution circuitry.
2. Lighting branch circuitry.
3. Appliance, receptacle and equipment branch circuitry.
4. Motor branch circuitry.
5. Control wiring.
6. Outdoor lighting and power.

1.3 STANDARDS:

A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:

BS 6346	PVC insulated, armoured cables for voltages of 600/1000V and 1900/3300 V
BS6004	Polyvinyl Chloride (PVC) insulated and PVC over sheathed cables - up to 300/500V - for electric power and lighting.
BS6724	Thermosetting insulated armoured cables - 600/1000V to 1900/3300V - with low emission of smoke and corrosive gases when affected by fire.

B. Where application of applicable codes, Trade Association standards, or publications appears to be in conflict with the requirements of this Section, an interpretation shall be obtained from the Architect/ Engineer.

1.4 QUALITY ASSURANCE:

A. Manufacturers: Provide products complying with these specifications and produced by the manufactures provide in the list with BOQ.

1.5 SUBMITTALS:

A. Shop Drawing submittals shall include, but not be limited to, the following:

1. The Contractor shall submit to the Engineer for review, a list of the proposed manufacturers of wire and cable, cable lugs, cable connectors and termination fittings listed herein. The Contractor may install wire and cable, cable lugs, cable connectors and termination fittings furnished by any manufacturer listed on the approved submittal.

2. Cut sheets on all 300/500 and 600/1000 volt conductors with manufacturers name, ratings and capacities, insulation characteristics, and available colors, clearly listed.

3. Cut sheets indicating all cable lugs, termination fittings and cable connectors.

4. Cut sheets indicating types of conductor identification bands.

1.6 DELIVERY, STORAGE AND HANDLING:

A. Provide factory-wrapped waterproof flexible barrier material for covering wire and cable wood reels, where applicable; and weather resistant fiberboard containers for factory-packaging of cable, wire and connectors, to protect against physical damage in transit. Damaged cable, wire, or connectors shall be removed from project site.

B. Store cable, wire, and connectors in their factory-furnished coverings, and in a clean, dry indoor space which provides protection against the weather.

PART 2 - EXECUTION

2.1 INSTALLATION

A. General: Install electrical cable, wire and connectors as shown, in accordance with the manufacturer's written instructions, the applicable requirements of "Standard of Installation", and recognized industry practices to ensure that products serve the intended functions.

B. Coordination:

1. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface.

2. Installer shall examine the areas and conditions under which cable, wire and connectors are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Inspect wire and cable for physical damage. Do not proceed with the work until unsatisfactory conditions have been corrected.

C. 600 Volt Building Wire and Cable:

1. Mains and feeders are to be run their entire length in continuous pieces without joints or splices[, unless otherwise indicated or noted].

2. Conductors may be run in multiple on sizes inclusive, provided all multiple conductors are the same size, length, and type of insulation, and are so arranged

and terminated as to ensure equal division of the total current between all conductors involved.

3. Before any wire is pulled into any conduit, the conduit shall be thoroughly swabbed in such a manner as to remove all foreign material and to permit the wire itself to be pulled into a clean, dry conduit. All conductors shall be pulled into the conduit at the same time.

D. 300 Volt Control/Signal Cable and Wire:

1. Install all low voltage wiring in a suitable raceway except in areas with accessible (lay-in) ceilings unless otherwise noted on Drawings Where cable is routed without a raceway, bundle all cables and suspend to one foot above ceiling using loop rings on 5' centers. Do not run cable loose on top of suspended ceilings. Do not attach cables to suspended ceiling supports or any mechanical, plumbing, or sprinkler piping. Conceal conduit except in mechanical rooms and areas where other conduit and piping are exposed. Fasten flexible conductors, which bridge cabinets and doors, neatly along hinge side and protect against abrasion. Tie and support the conductors neatly.

2. Number code or color code conductors appropriately for future identification and servicing of the system. Refer to consultants advice for additional requirements.

2.2 TESTING:

A. Feeder Insulation Resistance Test: Each new [and reused existing] 600 volt feeder conductor shall have its insulation resistance tested after the installation is complete except for connection at its source and point of termination.

1. Tests shall be made using a Biddle Megger or equivalent test instrument at a voltage of not less than 1000 volt dc. Resistance shall be measured between phase, neutral, and ground conductors and from conductors to raceway (ground). Readings shall be taken after 30 seconds and 60 seconds of Megger operation at slip speed and insulation resistance shall not be less than the 1000 MΩ

2. New conductors which do not meet or exceed the insulation resistance values listed above shall be removed, replaced, and retested.

3. Where reused existing feeders fail to meet the above insulation requirements, notify the Engineer in writing for direction prior to placing the existing feeders back in service.]

B. Neutral Testing: After all feeder and branch circuit conductors are terminated, neutral to ground testing shall comply with the following:

1. The resistance of the system's neutral to ground shall be greater than 10 kΩ with the system bonding jumper disconnected.
2. Repeat neutral to ground test for neutrals of separately derived systems.

C. Pre-energization Check: Prior to energization, check all new [and reused existing] branch circuit cable and wire for continuity of circuitry and for short circuits. Correct malfunction when detected. No submittal is required for this test.

D. Voltage and Current Values: The voltage and current in each main feeder conductor shall be measured and recorded after all connections have been made and the feeder is under load.

E. Submittals: Contractor shall furnish all instruments and personnel required for tests. Submit four copies of certified test results to Architect for review. Test reports shall include

conductor tested, date and time of test, test results, relative humidity, temperature, and weather conditions.

2.3 AS BUILT DRAWINGS

A. As-Built Drawings: Refer to Section 26 00 01, "Electrical General Provisions", for applicable requirements.

2.4 IDENTIFICATION

A. Identification: Refer to Section 26 05 53, "Identification for Electrical Systems", for color coding and markings for all conductors and cables.

END OF SECTION

Section-5: Grounding & Bonding

1.0 GENERAL

An Integrated Grounding System is one that establishes a single point ground (or earthing) system that achieves an acceptably low resistance ground and provides for a low surge impedance path from any point in the system. This concept is often referred to as a Common Point Grounding (CPG) System.

2.0 EARTHING SYSTEM COMPONENTS

Grounding system shall be composed of the following components:

- Chemically activated grounding electrodes, commercially known as AGE-T.
- Thin wall, soft copper tubing of at least one half-inch diameter, of at least ninety- nine (99%) percent pure copper.

3.0 EARTH INSTALLATION

1. Active Green Earth (AGE-) is an electro-chemical grounding electrode that automatically conditions the soil/rod interface. This is accomplished by absorbing local moisture to facilitate the electrolytic process. The installation must be accomplished in such a manner as to encourage this process.
2. To install the AGE-T, first bore a hole in the selected location to a diameter of not less than six (6) inches to accommodate the Earth Conductivity Enhancement Compound (ECEC) and a depth equal to the length of the selected rod plus one foot.
3. Remove all of the tapes covering the absorption and electrolyte holes.
4. Insert the electrode in the bored hole to its full length. It is preferable to leave the top exposed and protected by the special wall assembly, as illustrated. Pour 2 to 4 liters of water in the hole as it is being back filled.
5. Tamp the earth in place, leaving space to reach the connections and to install the well access assembly.
6. Make the connection to the AGE-T copper electrode.
7. Do not install in a place where watershed or downspout carry-off will flood the unit. Provide for carry-off when you install. The unit may be cemented or paved around, providing above instructions are followed and may be installed indoors.
8. Upon completion of installation of the earthing system, resistance-to-ground (earthing connection) shall be tested with a resistance tester. Where tests indicate resistance-to-ground is over 5 ohms, appropriate action shall be taken to reduce resistance to 5 ohms or less, by installing additional, properly spaced, ground electrode and treating soils in proximity to ground electrode. A retest shall be performed to demonstrate compliance.

4.0 TEST POINTS

These points are for testing of earthing systems. At these points hot work can be separated and can be tested for continuity and resistance. Test points should be made of brass and solidly fixed to wall at a height of 1.5 meter.

5.0 EARTH PITS

These should be made of pre cost concrete with a cover lid and should be placed over the electrode in level with the finished ground level. The cover lid should have marking showing its number and written "Earth Electrode" .

6.0 MAIN EARTHING SYSTEM

6.1 The contractor shall adequately allow in his tender for the provision and the installation of a complete earthing system required to meet the following requirements and shall ensure that the entire electrical installation is effectively bonded to earth as per BS 7430 Standards.

6.2 The contractor shall ensure that the whole of the electrical installation is both mechanically and electrically continuous throughout and is bonded to a suitable main earth in compliance with the IEE regulations and BS Code of Practice.

6.3 A test connection link shall be provided for testing purposes.

6.4 The nominal cross-sectional area of all earth continuity conductors shall be in accordance with the IEE regulations

6.5 All switchboards shall be provided with copper earth bar continuously run along the switchboard frames.

6.6 All switchgear, metal conduit and trunking systems, metal frames, enclosures, lighting fittings and cables sheaths shall be bonded together and connected to the earth tapes of the appropriate switchboard. Similarly all earth pins and metallic plates of socket outlets, switches, accessories and enclosures shall be bonded to earth with earth continuity conductors. Each individual earth path shall be electrically continuous throughout its length from the farthest point of the associated part of the system back to the main earth.

6.7 All earthing cables shall be installed in accordance with the relevant requirements called for in the cables section of this specification.

6.8 All bonding leads in the form of cable having a standard conductor shall be terminated in sheathed sockets and shall be rigidly bolted to earthing terminals.

6.9 All earthing cables shall be insulated with a PVC sheath. Where connection of the earth lead to the main earth is made with a stranded cable, the earth lead shall be double insulated with PVC.

6.10 Earth cable shall have same construction details as of phase cables.

6.11 Equipotential bonding conductors (6 mm^2 minimum) must be provided for metal pipes, water pipes, metal doors and other extraneous conductive parts and brought to the main earthing terminal in ground floor electrical room for final connection to the main earth pits. The cables shall be concealed in slab / wall upto final connection point.

6.12 The metal doors, curtain wall, building structure, door frames in electrical room, substations shall be provided with equipotential bonding and connected to the main Earthing System. Contractor should prepare and submit separate shop drawings with details for the earthing system.

6.13 Main equipmental bonding conductors in relation to the neutral of the supply shall be as per table 54H of BS7671 : 2001.

6.14 The earth rods shall be copper, corrosion resistant.

6.15 Provide separate earth pits as required and shown in schematic

6.16 Contractor shall be responsible for Substation earthing as per LESCO requirements.

6.17 The extraneous conductors parts in the building shall be bonded together.

6.18 The metal underside of raised floor and support elements shall be bonded to the common bonding network in addition to the following:

- Trunking, Tray , Chilled water / Sprinkler / Fire Fighting Pipe Work / Ductwork / HVAC Equipment, etc.

8.0 THERMO WELD

1. GENERAL

This specification covers the exothermic welding system for use in making electrical connections. The system supplied under this specification shall include weld metal, molds, tools and accessories as required.

2. STANDARDS

The exothermic welding system furnished under this specification shall meet the applicable requirements of Standard for Qualifying Permanent Connections Used in Substation Grounding. Independent test data showing conformance to IEEE Std. 80 and IEEE Std. 837 shall be readily available.

The exothermic welding system supplied under this specification must be approved by consultant.

3. SYSTEM

The system provides the ultimate in permanent molecular bonding. The process of exothermic welding in which no outside source of heat or power is required. Exothermic welding system comprise a complete range of joints and molds to suit all electrical connection application including bar to bar, bar to earth rod, bar to steel surface, cable to bar, cable to cable, cable to earth rod, cable to rebar and cable to steel surface and electronic ignitior (control unit)

4. APPLICATION

The exothermic welding system is used for in making electrical connections of copper to copper, copper to steel or copper to cast iron for grounding and cathodic applications.

Connections shall be suitable for exposure to the elements of direct burial in earth or concrete without degradation over the lifetime of the grounding system.

5. MATERIAL

Molds shall be made from:

a. Graphite material capable of withstanding high temperatures that are capable of providing an average life of not less than fifty separate exothermic welds.

b. Cordierite, refractory ceramic or other material suitable for a single connection.

Starting material (where used) shall consist of aluminum and copper and iron oxides. It shall not contain phosphorous, magnesium or any caustic, toxic or explosive substances.

Low voltage battery starting (where used), shall use an electric ignition system that does not use starting material.

Weld metal used for grounding connections shall contain copper oxide, aluminum and not less than 3% tin as the wetting agent. Weld metal used for cathodic connections shall not contain tin, but shall contain vanadium.

6. QUALITY CONTROL

Weld metal shall be controlled at the factory and subjected to routing and rigid quality control inspection procedures. The batch control lot number shall be packaged with the product for shipment from the factory.

a. Manufacturers shall be ISO9001:2000 certified.

b. Manufacturers shall have been engaged in the design and manufacturing of exothermic connection systems for at least twenty (20) years.

END OF SECTION

Section-6: Raceway & Boxes

1.0 GENERAL.

The work under this section consists of supplying, installing and commissioning of all material and services of the complete conduit & pipe system as specified herein and/or shown on Tender Drawings and stated in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and co-ordinate at site with other services for exact route, location and position of the electrical lines.

2.0 PVC CONDUITS.

All wiring for light, power, control and other circuits shall be carried out in Electrical Grade PVC pipe, minimum 1" dia, unless otherwise stated. The conduits and pipes shall be supplied complete with all accessories including bends, joints junction boxes and all cutting, repair, excavation backfilling, etc., required for complete installation. The conduits for internal wiring to lights, sockets and power circuit shall be of approved brand.

Manufactured smooth bends shall be used wherever conduit changes direction. The sharp 90 degree bends or tees shall not be allowed. All conduit accessories shall conform to same material specification as given above for conduit.

The bends shall have enlarged ends to receive conduit without any reduction in the internal diameter at joints.

The round junction box for ceiling light points shall be of PVC having minimum dimensions of 63 mm diameter and 63mm deep. The outlet box at wall light points shall be general purpose type having minimum dimensions of 63 mm diameter and 38 mm deep. Pull boxes and inspection boxes shall be installed in conduit runs where required to limit the pulling of the cables or for inspection purposes. The pull boxes shall be square having minimum dimension of 100mm and 50 mm deep. In all cases, the minimum length of inspection boxes shall be not less than four times the cable manufacturers recommended bending radius of the cable. These dimensions are minimum only and the Contractor shall determine the exact size keeping in view the ease of maintenance and installation. In general the use of pull boxes and inspection boxes shall be avoided. The pull boxes and inspection boxes shall be of 14SWG sheet steel provided with anti-rust paint and finished in enamel paint or powder coated (as approved by the Engineer during sampling stage) .

3.0 INSTALLATION.

The conduit shall be installed concealed in wall, column ceiling or under floor, on surface, above the false ceiling or as stated on the drawings. The drawings are diagrammatic and do not indicate the location of junction boxes, pull boxes or inspection boxes which shall be provided to suit site conditions.

The concealed conduits shall have a minimum of 25 mm concrete cover, when concealed in R.C.C works. The conduits in R.C.C works shall be laid before pouring of concrete. Chisel shall not be made in R.C.C structure for conduits and accessories after pouring of concrete. In slab, conduits shall be laid over the bottom reinforcement steel and tied firmly to it. The conduit outlet boxes shall be held firmly to finish with the surface of the slab or beam. At expansions joints, flexible conduits or alternate arrangement shall be provided.

Where conduits have to be concealed in cement concrete work after concreting or in block masonry, chases shall be made with appropriate tools and of required depth. The conduit shall then be fixed firmly in the recess and covered after plastering. All chases for concealing conduits shall be carried out by the Contractor. The Contractor will be responsible for bringing back the general finish to the condition that it was before the cutting and chiseling by the Contractor.

The work of conduit installation and cutting in cement concrete work or brick work shall be coordinated with civil construction so as not to cause any undue hindrances and delays in progress. The Contractor shall obtain approval of the Consultant for route, etc. to suit the site conditions before starting chiseling and cutting. All junction boxes, outlet boxes, pull boxes etc., shall be installed concealed so as to finish with the surface.

Bending of conduits by heating or otherwise can be adopted provided that the recommendation of conduit manufacturers are strictly followed. After completion of conduit installation, the system shall be checked for any charred or twisted portion prior to the pulling of wire. At all joints, PVC jointing solution must be used. Conduits while embedding under concrete , plaster and screed (in vertical position or horizontal) should have minimum of 25 mm gap.

The termination of conduits is shown diagrammatically on the drawings. The exact final location of the termination shall be coordinated with the equipment to be installed. Conduit ends pointing upwards or downwards shall be properly plugged, in order to prevent the entry of foreign materials. All openings through which concrete may leak shall be carefully plugged and boxes shall be suitably protected against filling with concrete. At all termination of conduit, soft bushes shall be fixed to prevent sharp edges of conduit ends from cutting or damaging the wires or cables to be pulled through them.

The entire conduit system shall be installed and tested before wiring is carried out. Any obstruction found shall be cleared by use of a cutting or other approved devices and the conduit be cleaned out before the installation of cable.

4.0 OTHER ACCESSORIES

Outlet boxes, pull boxes, inspection boxes, switch and socket outlet boxes, fan regulator boxes, etc. shall be of 14 SWG sheet steel, de-rusted, degreased, rust-proof with two coats of zinc chromate primer and painted with enamel or powder coated, complete with earthing terminal. All boxes shall have ample wiring space, and boxes used for outdoor areas shall be weather-proof type.

END OF SECTION

Section-7: Cable Trays

PART 1 GENERAL

1.1 General Requirements
1.2 Scope of Work
1.3 Quality Assurance
1.4 Submittals
1.5 Related Work

PART 2 PRODUCTS

2.1 General
2.2 Cable Tray

PART 3 EXECUTION

3.1 Installation
3.2 Earthing
3.3 Fire Barriers

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

1. The work of this Division shall be governed by the following documents:
    1. Conditions of Contract.
    2. Instructions to Tenderers.
    3. Form of Agreement.
    4. General and Special Conditions of Contract.
    5. Form of Tender.
    6. Appendices.
    7. Applicable Divisions.
2. Comply with requirements of all sections of this Division
3. It is the Contractors responsibility to be fully aware of and comply with all of the requirements of the above listed documents.

1.2 SCOPE OF WORKS

1. Under this section of the Contract cable tray (cable tray) shall be installed to support distribution cables, communication cables and all wiring cables not generally installed in conduit and or trunking.
2. The cable tray shall be installed in such a manner to enable easy access for cable installation.
3. The cable tray shall vary in type and sizes, ie: where large cables are installed, ladder rack type cable tray shall be permitted, where smaller type communication cables are installed, ventilated type cable tray shall be permitted, unless otherwise stated.
4. Cable tray shall be galvanized finished or as specified in BOQ.
5. Cable ladders shall be installed in risers for the full length of the risers unless otherwise instructed by the Engineer.

1.3 QUALITY ASSURANCE

1. Acceptable Manufacturers
    1. Subject to compliance with the requirements of the Contract Documents, acceptable manufacturers are to be firms regularly engaged in manufacturer of all materials specified in this section of types and sizes required, whose products have been in satisfactory use under similar service conditions for not less than ten years.

1.4 SUBMITTALS

1. Submit the standards to which the cable tray is manufactured to.

2. Submit shop drawings and data in accordance with the general requirements of the contract.

3. Indicate the various types of cable tray with terminology used.

4. Show actual cable tray installation details, size and suspension system.

1.5 RELATED WORK

1. Section 26 05 19 Wire and Cables.

PART 2 PRODUCTS

2.1 GENERAL

1. The cable tray system shall be of one manufacturer and shall include factory made trays, tray fittings, connections, complete with accessories and supports to from a complete tray support system.

2. The cable tray system shall include the following factory-made tray elements. Straight trays and ladders, fittings and horizontal and vertical bends of various angles crosses, tees, wyes, reducers, vertical riser elements, connectors, joint plates and all necessary fixing accessories including supports. No local or site fabrication of any cable tray system including ceiling and wall supports are acceptable. Threaded rods for ceiling supports are not acceptable.

2.2 CABLE TRAY

1. The whole of the tray work, fittings, supports shall be of mild steel hot dipped galvanized after manufacture or as specified in BOQ. The thickness of the protective sheath on any element shall not be less than 60 microns.

3. Insert elements, bolts, screws, pins etc., shall be mild steel cadmium plated/hot dip galvanized.

4. Tray work shall have oval perforations. Ladder type trays shall be used as required and/or approved by the Engineer.

5. All trays (straight and fittings) to be heavy duty returned flanged type unless specified otherwise.

6. Tray component are to be accurately rolled or formed to close tolerance and all edges rounded. Flanges are to have full round smooth edges.

7. Unless indicated otherwise on drawings, cable trays shall be used in the range and 150mm to 750mm wide, in five preferred standard sizes: 150, 300, 450, 600 and 750mm.

8. Other sizes shall be used where specified or as approved by the Engineer.

9. Return flanges shall be a minimum of 10mm deep, unless otherwise specified.

10. Minimum radii at side rails, horizontal, and vertical tees and crosses shall be in accordance with the Manufacturer's standard.

PART 3 EXECUTION

3.1 INSTALLATION

1. Install all cable trays and ladder racks strictly in accordance with IEE and local authorities requirements.

2. Drilling, machining or cutting shall not be carried out after application of protective coat, unless previously agreed by the Engineer. If cutting or drilling is necessary, edges shall be cleaned up and painted with zinc-based paint before erection.

3. Provision shall be made when installing all cables and cable trays for the expansion and settlement of the building.

4. Cables shall be fixed to the trays/ladders by means of PVC cleats and flame-retardant cleats for flame/fireproof cables with galvanized bolts, nuts and washers. Use galvanized metal trefoil cleats with rubber pad for single core cables

5. The Contractor shall submit calculations relating to tray / ladder work and tray / ladder supports demonstrating acceptable mechanical stresses and sag.

6. Where cable tray must pass below a beam a short length of tray shall be installed on the underside of the beam with 25mm spacers between the tray and the beam underside surface. Cables shall be strapped rigidly to the tray to prevent any possible sag in the cables.

7. Where cable tray is intended to cross a series of beams the tray shall be supported from each beam it crosses by metal supports suspended from below the underside of the beam - the space between the tray and the beam underside surface shall not exceed three times the diameter of the largest cable to be carried on the tray.

8. Cable tray covers are required as specified in BOQ.

3.2 EARTHING

1. The entire cable tray and ladder system shall be bonded and 12mm x 1.5mm braided tinned copper shall be bolted across each joint in the system by means of galvanized nuts and bolts, complete with flat and spring washers.

2. Tray systems shall be bonded to the main building earthing system as required or directed by the Engineer.

3.3 FIRE BARRIERS

1. Arrange for opening in fire rated walls, and floor for width and depth of cable tray to run through in addition to the specified clearance of the above cable trays.

2. Arrange and make good fire rating of floors or walls after cables have been installed. For all floor openings of all risers (telephone, power) except vertical telecom cable risers where grating shall be provided.

3. All openings / sleeves within floor slabs and fire rated walls shall be sealed with proper fire rated material.

END OF SECTION

Section-9: Dry Type Transformer

PART 1 GENERAL

1.01 DESCRIPTION

A. Work Included:

1. The scope of work under this section includes the following for Dry type distribution transformers with medium-voltage primaries as specified here in:

2. The contractor shall supply, install, commission & test dry cast resin transformer complete with connections, terminations and accessories. The cast resin transformer shall be designed and manufactured for continuous indoor operation in a tropical climate on a 3 phase distribution system with solidly earthed neutral. It shall be of a short circuit, impulse and moisture-proof design. The case resin transformer shall be designed, manufactured and tested according to the latest edition of International Electro technical Commission (IEC) Standard 60076-11. It shall be compact and suitable for easy installation on site.

3. The transformer shall be designed to operate in an enclosure of the protection class IP23 without de-rating.

4. The electrical connections to other equipment shall be properly coordinated to form a complete system (s) complying with this specification.

5. Workshop drawings shall be provided for each transformer. These drawings shall include fully dimensioned external and internal general arrangements showing all principle dimensions, weights, foundation/cable/bus bar entry details and the positions of all functional devices, schematic drawings showing all windings, method of connection, terminal markings, and IP rating.

6. Transformers in the context of this specification shall comprise assemblies of a magnetic core, primary and secondary windings, supporting framework and enclosure.

   Unless otherwise specified all tests used shall comply with IEC 60076-11 and DIN/VDE standards

7. The design, manufacture, selection, installation, testing, commissioning and subsequent maintenance of all equipment and materials described in this specification shall comply with the requirements of, the electricity at work regulations and the IEE wiring regulations.

   Where more onerous requirements are specified herein, the conditions of this specification shall take precedence.

1.02 PROJECT CONDITIONS

A. GENERAL

The transformers shall comply with the requirements of IEC 60076-11 in respect of partial discharge, impulse withstand short circuit strength.

B. Service Conditions: IEEE C37.121, usual service conditions

C. RATED VOLTAGE

Unless otherwise specified the rated voltage class of the primary windings shall be 11kV and secondary windings 0.4 kV, at a frequency of 50Hz. The windings shall be connected for vector group Dyn 11.

D. THERMAL RATING

Transformers shall be designed and manufactured to operate continuously at the nameplate rating, in an ambient temperature not exceeding 50°C and RH not exceeding 100%, unless otherwise specified.

The manufacturer shall confirm any de-rating necessary, should the transformers be required to operate in conditions exceeding those specified.

E. LOSSES

Losses at no-load and loaded conditions shall be the lowest achievable for the transformer type specified. These losses shall be stated in the schedule(s) which accompany this Specification.

F. NOISE LEVELS

The manufacturer shall confirm the guaranteed noise levels, Measurement of sound levels shall comply with IEC 60076-10. The transformer shall be provided with noise reduction support blocks in order to reduce noise level.

G. ELECTROMAGNETIC COMPATIBILITY

Radiation of electromagnetic signals shall not exceed the limits of BS 800 and BS 6667.

Where transformers may be vulnerable to voltage transients, they shall be protected by surge suppressor, which will reduce transients below the levels of the type tests.

1.03 QUALITY ASSURANCE

A. Electrical components, Devices and Accessories; Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

1.04 SUBMITTALS

A. Comply with requirements

B. Product data: For each type and size of transformer indicated.

C. Shop drawings: Diagrams including power signal and control wiring.

D. Manufacturer seismic qualification certification: Submit certification that transformers, accessories, and components will withstand seismic forces.

PART 2 PRODUCTS

2.01 MANUFACTURERS

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to the list of manufacturers given in 26 05 00.

2.02 DESIGN REQUIREMENTS:

A. CORE CONSTRUCTION

The transformer core shall be built of lamination, comprising grain orientated silicon sheet steel which is insulated on both sides. To protect the core against corrosion and improve noise levels the core assembly shall be coated after assembly with resin based paint.

The lamination shall be clamped at top and bottom by steel channels, which are interconnected by vertical steel bolts. The bottom steel channels shall be used to support the transformer and the top steel channel shall incorporate lifting lugs.

The bottom core clamping channels shall be bolted to supporting steel cross-channels placed at 90° to the transformer length, such that the whole unit is stable and able to support the whole weight of the transformer with a safety factor of two. Wheels shall be fitted to the cross-channels which shall be bi-directional or steerable

The supporting cross-channels shall be insulated from the core- clamping channels by anti-vibration pads.

The core-clamping and supporting steel work after all forming, drilling and shaping operations shall be thoroughly digressed and rinsed prior to application of a zinc phosphate primer, rinsed again and finally coated with an oven baked epoxy paint.

B. COIL CONSTRUCTION

Each transformer shall be a double wound type with both the H.V. and L.V. windings individually encapsulated in rigid steel mould. The coils shall be impregnated with quartz filled epoxy resin and cast under vacuum, to produce a smooth finish without voids and undulations.

The size and spacing of the conductors used in the windings shall be such that the coils are self-supporting prior to impregnation and where applicable, shall allow the epoxy resin to fill all of the space in and between adjacent layers and turns.

The coefficients of expansion of the windings and epoxy resin shall not differ by more than 15%.

The windings shall be made of copper, utilizing round or rectangular sections, or foil, as detailed in the attached schedule(s)

C. MECHANICAL FORCED VENTILATION (AF)

Where specified mechanical forced ventilation shall be employed to further cool the transformer windings and thus increase the performance rating during short highly loaded periods.
The cooling system shall be automatically controlled by sensing the low voltage top winding temperature.

The system shall comprise a number of single-inlet, single-width centrifugal fans, each connected to a discharge duct situated directly below the transformer coils, or axial fans, situated to direct the air flow through the coils.

Duct work shall be of sheet metal construction to DW/142 low pressure classification, or of greater thickness to suit manufacturing procedures, or incorporated as part of the base frame construction if required.

Ducts shall have discharge outlets, protected with metal mesh screens to exclude debris, to correspond with core positions on each side. Ends shall be capped.

Fans shall have spigot inlets, with 6 mm protective wire guard, and flanges outlets to connect

to mating flanges on the air ducts, and joint to incorporate a flexible gasket.

Fans shall be direct driven by an internally fitted external rotor type motor with extended lubricators.

Each motor shall be supplied from a starter, complying with DIN/VDE standards and shall be housed in a purpose-mad cabinet also accommodating automatic control elements and status indication lamps.

The duty of each fan shall be identical and selected so that the total quantity of air delivered is sufficient to maintain the transformer temperature within the specified limits.

Fans shall be type tested to DIN/VDE Standards Impeller shall be mild steel to DIN/VDE standards and of welded construction, shaft height machined steel, bearings roller type or sealed for life. Fan scrolls shall be of welded construction.

For shaft powers below 1kW stamped formed strip impellers may be used provided required efficiency and balance grade can be achieved.

Where fan static pressure is less than 1kpa lock-formed joints and spot welds may be used.

Fans and ductwork shall have a fully protective paint system to the same standard as the core construction.

D. INTERTURN INSULATION

High and low voltages coils shall be provided with very high integrity inter turn insulation to Class F, to withstand the thermal and mechanical stresses under the specified operating conditions.

E. MOUNTING OF COILS

Coils shall be sandwiches between the core clamping channels but separated from them by insulated support blocks. These blocks shall be radially located top and firmly fixed to withstand vibration and absorb coil expansions and contractions.

F. INSULATION CLASS

The HV and L.V windings shall be of insulation class F in respect of mechanical and electrical strength (Partial Discharge Test). The maximum continuous operation temperature shall be within the limit of the maximum system temperature according to IEC 60076-11 i.e. 155^{o}C.The maximum temperature rise shall be limited to 90K at 50^{o}C ambient. The transformer shall operate at higher ambient temperature with reduced load without getting damaged.

G. DEGREE OF PROTECTION

When specified, a transformer enclosure shall be designed to suit the location and anticipated environmental conditions. This shall provide a degree of protection not less than IP23 in compliance with IEC 60529, and shall comply with there Electricity at work Regulations.

H. TYPE OF RESIN, FILLER ETC

The particular manufacturer's insulation system shall dictate the type of resin and filler but the following guidelines shall be complied with.

The resin shall ensure a minimum power frequency breakdown stress 10kV/mm when tested to IEC 60243.

The completed cast resin coil shall be self extinguishing in the event of fire. The testing

method shall comply with IEC, DIN/VDE standards. Type test certificates are required to confirm the above.

2.03 DRY-TYPE DISTRIBUTION AND POWER TRANSFORMERS

A. Description: Cast Resin and with insulation system rated at 220 deg C with and 80 deg C average winding temperature rises above a maximum ambient temperature of 45 deg C.

B. Primary Connection: Air Terminal compartment with removable cover and predrilled copper bus bars.

C. Secondary Connection: Air terminal compartment with removable cover and predrilled copper bus bars.

D. Secondary Connection: Transition terminal compartment with connection pattern to match switchgear.

E. Insulation: Rated at 220 deg C with temperature rise of 115 deg C, maximum rise above 45 deg C.

F. Basic Impulse Level: 95 kV

G. Full-Capacity Voltage Taps: Four, 2.5 percent taps, 2 above and 2 below rated primary voltage; with externally operable de-energized, tap changer; position indicator and padlock hasp.

H. Cooling System: Force cooled.

I. Sound level may not exceed sound levels listed in BS, without fans operating.

J. Impedance: 6.0 percent.

K. High Temperature Alarm: Local, audible and visual alarm and contacts for remote alarm.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install and anchor transformers on concrete bases according to manufacturer's written instructions and according to seismic codes applicable to project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit and 4 inches (100 mm) high.

2. Use 3000-psi (20.7 – Mpa), 28 day compressive strength concrete and reinforcement as specified in Division 03 Section "Cast in Place Concrete".

3. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18 inch (450 mm) centers around full perimeter of base.

4. Anchor equipment with epoxy embedded anchor bolts that extend through concrete base and anchor into structural concrete floor.

B. Maintain Minimum clearness according to manufacturer's written instructions and NFPA 70.

3.02 HANDLING FACILITIES

A. LIFTING

Transformers shall be provided with permanently fitted lifting lugs or eye bolts to facilitate handling by crane or hoist.

Transformers shall be equipped with jacking points to facilitate the removal and or insulation pads.

The bottom supporting steel work shall be fitted with holes or have lugs attached for the attachment of hauling apparatus.

B. FRAME WHEELS

Transformers shall be designed for floor mounting and be provided with removable bi-directional or steerable rollers.

The rollers shall be lockable or means provided to prevent movement of the transformers after Installation

3.03 CONNECTION FACILITIES

A. CONNECTION METHODS

Connection methods shall comply with IEC 60076 Provision shall be made by the manufacturer for the mounting and connection of cable boxes and/or bus bars as specified for the HV and LV conductor connections.

Where HV and LV cable boxes and/or bus bars are specified these shall generally be arranged on opposite sides of the transformer. However exact positions shall suit the specified requirements of each individual situation.

LV cable terminations shall be kept separate from the HV cable connections and insulated to the specified voltage and able to withstand the specified short circuit currents.

All HV coil interconnections shall be insulated for the specified voltage, and able to withstand the specified short circuit currents.

An earthing terminal shall be provided at a convenient point on the supporting steel work. All steel work shall be bonded to the earthing terminal if it is not electrically continuous. Provision shall be made for making an earth connection to the neutral of the LV windings, should this be required.

B. TERMINAL MARKINGS

HV and LV winding terminals shall be clearly marked with characters in accordance with IEC 60076.

The characters shall be stamped or engraved on securely fixed, durable and non-corrodible plates.

3.04 TAP CHANGING FACILITIES

A. TAP CONNECTIONS AND LINKS

Each transformer shall be provided with tapping on the HV winding to cater for supply voltage variations in the range +2.5% and + 5% in compliance with IEC 60076.

Tap changing shall be effected by off-circuit tapping links.

A visible warning notice shall be fixed adjacent to the tapping links and worded as follows:

" WARNING - OFF LOAD TAP CHANGING LINKS – ISOLATE
HV AND LV SUPPLIES TO TRANSFORMER BEFORE OPERATION"

3.05 THERMAL PROTECTION

Each transformer shall be provided with a system of thermal protection and temperature monitoring.

Temperature sensing thermistors shall be mounted in each LV coil as close as practicable to its hot spot. The thermistors shall be wired back to an electronic controller fitted on the transformer.

The thermistors shall be used to indicate winding temperature, and provide alarm and trip indications, and to operate forced cooling fans and trip HV circuit breakers where specified. Volt-free contacts shall be provided for relaying signals to remote equipment.

Wiring from the thermistors to the temperature controller shall be carried out with single core copper cables to DIN/VDE standards with LEF insulation. Cables shall be contained in galvanized steel conduit supported from the transformer steel work.

The temperatures at which the cooling fans shall be switched on and off shall be adjustable within preset limits.

The power supply for the cooling fans shall be provided from the particular transformer via a suitably fused switch. This switch shall bear the inscription in yellow letters on a black background:

" WARNING - SUPPLY FOR TRANSFORMER COOLING FANS -
DO NOT SWITCH OFF"

The starter assembly for the cooling fans shall comply with this Specification. A warning label shall be fixed adjacent to the main isolating switch bearing the inscription:

" WARNING - SUPPLY FOR TRANSFORMER COOLING FANS -
DO NOT SWITCH OFF"

3.06 RATING PLATES

Rating plates shall be fitted complying with IEC 60076-11

3.07 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: Perform the following voltage monitoring after substantial Completion but not more than six months after Final Acceptance.:

1. During a period of normal load cycles, perform seven days of continuous three phase voltage recording at secondary terminals of each transformer. Voltage

unbalance greater than 1 percent between phases, or deviation of any phase voltage from nominal value by more than plus of minus 5 percent during test period is unacceptable.

2. Corrective Action: If test results are unacceptable, perform the following corrective actions, as appropriate.

   a. Adjust transformer taps.

   b. Prepare written request for voltage adjustment by electric utility.

3. Retest: After corrective actions have been performed repeat monitoring until satisfactory results are obtained.

4. Report: Prepare written report covering monitoring and corrective actions performed.

3.08 TESTING INSPECTION AND COMMISSIONING

The tests to be carried out in accordance to IEC 60076-11 and in presence of owner's consultant and owner at factory. Test report shall be provided and shall include but not necessarily be limited to :

A. Visual and Mechanical Inspection

1. Inspect physical and mechanical condition including evidence of moisture and corona.

2. Inspect anchorage, alignment, and grounding.

3. Prior to cleaning the unit, perform as-found tests, if required.
4. Clean the unit.

5. Verify that control and alarm settings on temperature indicators are as specified.

6. Verify that cooling fans operate.

7. Inspect bolted electrical connections for high resistance using one of the following methods:

   - Use of low-resistance ohmmeter
   - Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method.
   - Perform thermo graphic survey.

8. Perform specific inspections and mechanical tests as recommended by manufacturer.

9. Perform as-left tests.

10. Verify that as-left tap connections are as specified.

11. Verify the presence of surge arresters.

B. Electrical Tests

1. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
2. Perform insulation-resistance tests winding and each winding ground with test voltage. Calculate polarization index.

3. Perform power-factor or dissipation-factor tests in accordance with the test equipment manufacturer's published data.

4. Perform a power-factor or dissipation-factor tip-up test.
5. Perform turns-ratio tests at the designated tap position.

6. Perform an excitation-current test on each phase.

7. Measure the resistance of each winding at the designated position.

8. Measure core insulation-resistance at 500 volts dc if core is insulated and if the core ground strap is removable.
9. Perform an over potential test on all high- and low-voltage windings-to-ground. See ANSI/IEEE C57.12.91, Sections 10.2 and 10.9.

10. Verify correct secondary voltage phase and phase neutral after energization and prior to loading.

C. Test Values

1. Compare bolted connection resistances to values of similar connections.

2. Bolt-torque levels should be in accordance with specified by manufacturer.

3. Micro ohm or mV drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 50 percent of the lowest value.

4. Insulation-resistance test values at one minute should be in accordance with applicable standard.

5. The polarization index shall be compared to previously obtained results and should not be less than 1.0.

6. Turns-ratio test results should not deviate more than one half percent from either the adjacent coils or the calculated ratio.

7. Tip-up test watts loss values should indicate no significant increase in power factor.

8. Temperature corrected winding-resistance test results should compare within one percent of previously obtained results.

9. Typical excitation current test data pattern for three-legged core transformer is two similar current readings and one lower current reading.

10. Core insulation-resistance values should be comparable to previously obtained results but not less than one mega ohm at 500 volts dc.

D. SITE TESTS

All site tests shall be carried out in accordance with this Specification.
After delivery to site each transformer shall be inspected in the presence of the Owner's consultant, prior to installation.

After installation on properly prepared foundations each transformer shall be tested and inspected in the presence of the Owner's consultant.

The HV and LV winding connections shall be demonstrated as providing the specified polarity and phase rotation and tap connections.

The HV and LV windings shall be tested for continuity and insulation resistance with a 1000v insulation tester. The insulation resistance between adjacent windings shall not be less than 100 M ohm.

After the HV windings are energized, it shall be demonstrated that the voltage and phase rotation at the LV terminals are as specified.

3.09 PARTICULAR REQUIREMENT – ACCESS

The specified transformers are located as indicated on the drawings.

This places restrictions on the transformers' physical dimensions in case it is necessary to remove/replace a transformer once the installation is handed over and in use.

The Contractor shall demonstrate to the Owner's consultant that the manufacturer's transformer type selected could be removed/replaced (without incurring builders work) with access through the proposed location.

If required by the Owner's consultant, detailed dimensioned drawings proving removal/replacement is practical shall be provided.

Section-10: MV Switchgear

PART 1 GENERAL

1.02 DESCRIPTION

B. Medium Voltage Switchgears:

1.03 SCOPE

B. The work under this section consists of supplying, installing, testing and commissioning of all material and services of the complete MV switchboards as specified herein or stated on the Drawings and in the Bill of Quantities.

C. The Contractor shall discuss the electrical layout with the Engineer and co-ordinate at site with other services for exact location and position of the MV Switchboards.

1.04 QUALITY ASSURANCE

A. Electrical components, Devices and Accessories; Listed and labeled as defined in IEC 62270-200, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

1.04 SUBMITTALS

G. Product data: For each type and size of MV switchgear indicated.

H. Manufacturer seismic qualification certification: Submit certification that the switchboard, accessories, and components will withstand seismic forces.

I. Submit shop drawings and product information for approval and final documentation in the quantities listed.

J. Documents for Approval:

1. General arrangement drawing showing dimensioned elevation and floor plan, side views, foundation details and one-line diagram.
2. Panel arrangement drawing showing layout of devices on the panel doors.
3. Three line diagrams.
4. DC Schematics.
5. Nameplate engraving drawings.
6. Bill of material.

K. Final Documents: Record documentation to include:

1. Documents listed above.
2. Wiring diagrams.
3. Recommended spare parts list for start-up support.
4. Instruction manual.

1.05 PROJECT CONDITIONS

A. Service Conditions: As specified in general conditions of contract.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers:

Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to the list of manufacturers.

2.02 Medium Voltage Switchgear

A. Enclosure Specification:

The enclosure must be Metal Clad as per IEC 62270-200 and shall place in an ambient condition not more than 50°C with IP 42 rating. The MV switchgear shall be 12 SWG sheet steel fabricated floor mounting, cubicle type indoor, totally enclosed, dust tight and vermin proof.

Basic Data:

Enclosure Material:	Metal Clad as per IEC 62270-200
Ambient Temperature:	50°C
Installation Type:	Indoor
Degree of Protection:	IP 42
Color:	RAL – 7035 (or as approved by the Engineer)
Name Plate:	Stainless steel
Pocket Drawing:	Suitable Location

B. Ratings:

Peak impulse withstand voltage of 95kV and 1 minute power frequency withstand test voltage of 36 kV rms. The switch gear must be capable of carrying the short-time current (I^{th}) for t=3 sec. and must withstand the mechanical short circuit stresses by peak short-circuit current (Is).

C. Components:

1. Vacuum Circuit Breaker

VCB must be with-draw able type with rated voltage 12 kV at 50 Hz. The rated current of VCB must be 630A/800A with short circuit making capacity of 50 kA and short circuit breaking capacity of 25 kA. The insulation level of VCB must be 95 kV (BIL).

Capacity and Basic Data:

Breaker Type:	Withdraw-able Vacuum Circuit Breaker
Rated Current:	(As shown on drawings)
Rated Nominal voltage:	11kV
Rated Maximum voltage:	12 kV
Operational Frequency:	50Hz
Rated Short Circuit Making Current:	50kA
Rated Short Circuit Breaking Current:	25kA
Rated Basic Insulation Level (BIL):	95kV
Auxiliary Contacts:	Provision for remote indication and/or as required
Heater and audible alarm:	220V AC from substation L.Vswitchboard
Motor Spring:	220V AC from substation L.T switchboard

Interlocking

Any interlocking if required inside the M.V switchboard and between M.V switchboard and other equipment shall be provided as stated on the drawing.

2. Bus-bars

The bus-bar shall be made of high conductivity electrolytic 99.9% pure copper insulated and mechanically braced to safety to with-stand the stresses due to short circuit currents.

Bus-bar Specification:

Material of Conductor / Bus-bar: Tin Plated Copper & Sleeved

3. Protective Relays

The circuit breaker shall be provided with inverse definite minimum time, non-directional relays with over current, earth fault and instantaneous tripping. Relay must be provided with setting ranges as follows:

Basic Data:	
Relay Type:	Self Powered (Numerical)
Setting Ranges:	O/C = 0.2 – 40 I_n
(Refer the Detailed Specs)	E/F = 0.05 – 10 I_n
Over-current setting range	50-20% of CT secondary rating
Earth-fault setting range	20-80% of CT secondary rating
Short-Circuit setting range	200-800% of CT secondary rating.
Time setting range	0-1 second
Connection	Current Coil 5Amp secondary of CT,
Tripping	Series tripping through CT.

4. Meters

Digital ammeters and voltmeters having front dimensions of 96 x 96 mm, voltmeter shall have measuring range of 0-15 kV and ammeters measuring range shall be as shown on the drawing. Ammeter and voltmeters shall conform to B.S.S. accuracy class 1.5 and suitable for connection to the secondary of PTs and CTs respectively as described in these specifications.

Kilowatt-Hour (kWh) and Kilovolt-amp hour (kVAh) meter shall be suitable for 3 phase, 3 wire 50 Hz balanced and unbalanced loads. The kWHr meter shall also be provided with maximum demand indicator and a built in switch for operation at an interval of 15 minutes.

5. Earthing Switch

The three-pole isolating switches shall be suitable for earthing of equipment and shall be rated to safely carry the fault current due to inadvertent closing of supply circuit breaker and also for making duty on a fault.

6. Current Transformer

MV switchgear must be provided with current transformer with following ratings and characteristics:

Cast Resin type transformer with three single units for each phase. Current transformer shall have transformation ratio of 400/5 A (or as specified by Consultant). CT must be designed for rated voltage of 12 kV and insulation level of 95 kV (BIL). The burden and accuracy class for protection purpose must be 5P20, 15 VA and for metering purpose to be 0.5M5, 10VA.

Basic Data:	
Type:	Cast resin.

Transformation Ratio:	As shown on the tender drawing.
Rated Voltage:	12kV
Rated Insulation Level:	95kV BIL
Withstand Short Circuit Level:	25kA
Protection Class & Burden:	5P20, 15VA
Metering Class & Burden:	0.5M5, 10VA
Number:	Three single phase unit.
Duty:	For operating relays/meters and instruments.
Accuracy:	5P 20 for protection and 1.0 for measuring with security factor 5.

7. Voltage Transformer

MV switchgear must be provided with voltage transformer with following ratings and characteristics:

Cast Resin type transformer with three single units for each phase. Voltage transformer shall have transformation ratio of 11 kV/110 V. VT must be designed for rated voltage of 12 kV and insulation level of 95 kV (BIL).

Basic Data:	
Type:	Cast resin.
Transformation Ratio:	11kV/110V
Rated Voltage:	12kV
Rated Basic Insulation Level (BIL):	95kV
Burden:	100VA

8. Surge Protection

Surge Arresters shall be provided in HT switchboard, wherever required as shown on drawing. The 11 kV surge arresters shall have following characteristics. Equipment will be tested in accordance with the relevant IEC standard.

Basic Data:	
Peak Current Surge:	100 kA
Service (rated voltage):	11 / 1.732 kV rms
Voltage Class (highest system voltage:	12 kV rms

9. Operation Counter

The operation counter must be provided to count 10,000 operations.

10. Mechanical Interlocking Scheme.

- ✓ Prevent withdrawing or inserting trolley when the breaker is "ON".
- ✓ Prevent closing the circuit breaker when the trolley is between service & isolated position.
- ✓ Prevent decoupling the low voltage plug when the breaker is in service position.
- ✓ Prevent closing of the earthing switch (if opted), before the trolley is in the isolated position.
- ✓ Prevent inserting the trolley, when the earthing switch (if opted) is in the closed position.

Codes and Compliance

Switchgear:	IEC 62271-200
VCB:	IEC 62271-100
Disconnector / Earthing switches:	IEC 62271-102
Current Transformers:	IEC 60044-1
Potential Transformers:	IEC 60044-2
Degree of Protection:	IEC 60529
Installation Method:	IEC 61936-1
Insulation:	IEC 60071

11. MIMIC BUS

3mm x 12mm (color selected by purchaser) acrylic mimic BUS shall be supplied on each unit outlining the one-line diagram power circuits on front surface of the switchboard.

PART 3 EXECUTION

3.1 INSTALLATION

The MV switchboard shall be installed at location shown on the drawing. The cable trenches shall be constructed as part of civil works. The Contractor shall co-ordinate with the civil works for providing any openings, holes, etc., in time to avoid any breakage/damage to completed works. In case such provisions in civil works for installation of electrical equipment are not made or made incorrect, the same shall be rectified by the electrical Contractor at his own cost and to the satisfaction and approval of Engineer.

General: A Bidder shall provide 5 year warranties, parts included on all switchgears.

3.2 DEMONSTRATION

Switchgear Manufacturer shall provide a factory-authorized service representative to train Owner's maintenance personnel in the following:

1. In procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
2. Review data in the maintenance manuals.
3. Schedule training with Owner with at least three week's advance notice.

3.3 FIELD SERVICE

Switchgear manufacturers own (same name as the manufacturer) field service office shall be located not more than a three-hour drive from the installation site. And have at least 10 years experience in the installation, startup and testing of the said switchgear.

END OF SECTION

Section-12: Switchboards & Panelboards

PART 1 GENERAL

1.1 General Requirements
1.2 Scope of Work
1.3 Quality Assurance
1.4 Submittals
1.5 Factory Testing

PART 2 PRODUCTS

2.1 References
2.2 Sleeves for Primary Service Cables
2.3 380/220 Volt Secondary Switchboards
2.4 Distribution Panel boards
2.5 Final Distribution Boards
2.6 Plant and Field Tests
2.7 Switchgear Components for MDBs, MCCs, SMDBs, OEBs and All Other Control Panels
2.8 Automatic Power Factor Correction Equipment
2.9 Riser Diagram

PART 3 EXECUTION

3.1 Electric Service
3.2 Installation of Switchboards
3.3 Installation of Distribution Boards
3.4 Automatic Power Factor Correction Equipment
3.5 Testing & Coordination Study of Distribution
3.6 Co-ordination Study
3.7 Owner's Equipment Boards
3.8 Training

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

.1. The work of this Division shall be governed by the following documents:

.1. Conditions of Contract.

.2. Instructions to Tenderers.

.3. Form of Agreement.

.4. General and Special Conditions of Contract.

.5. Form of Tender.

.6. Appendices.

.7. Applicable Divisions.

.2. Comply with requirements of all sections of this Division particularly Section 26 24 16 Electrical General Provisions.

.3. It is the Contractors responsibility to be fully aware of and comply with all of the requirements of the above listed documents.

1.2 SCOPE OF WORK

.1. Supply, install and connect all main distribution equipment and make the utility service connections all as described hereinafter and in accordance with the requirements of the Contract Documents.

.2. The service cables provided by LESCO from the MV Switch room, Sub-station. Transformer secondary at 380/220V 50 Hz. shall be connected to free standing cubicle switchboards, sized in accordance with the capacity of the sub-station transformers, as shown on drawings.

.3. The switchboards shall comprise of main breakers, indicating instruments and outgoing breakers to provide a complete service and distribution system for the whole complex.

.4. Generally, the sub-distribution shall be carried out by means of:

.1. XLPE/SWA multi-core armoured cables to the various locations terminating at distribution panelboards, M.C.C. panels and items of electrical equipment.

.2. Where electrical loads are high, and volt drop a consideration due to lengthy runs, copper bus duct shall be installed to provide adequate distribution.

.3. Distributions from panel boards shall be generally in conduit and single copper conductors drawn into the conduit all as specified in other sections of the specification.

1.3 QUALITY ASSURANCE

.1. Acceptable Manufacturers

.1. Subject to compliance with the requirements of the Contract Documents, acceptable manufacturers are to be firms regularly engaged in manufacture of switchboards, whose products have been in satisfactory use under similar service conditions for not less than ten years, and independently certified to ISO 9000/BS.

.2. Regulatory Requirements

.1. All components shall meet all local standards listed and labeled, and comply with BS 5750 Part 1.

.2. All components and complete assemblies shall be rated for and capable to withstand ambient conditions of 50^{O}C and 100% R.H.

1.4 SUBMITTALS

.1. Reference Applicable Divisions - Submittals.

.2. Reference Applicable Divisions - Shop Drawings, Product Data & Samples.

.3. Shop Drawings.

.1. Switchboards

Distribution panel boards
Power & Lighting panel boards
Air Circuit Breakers
Moulded Case Circuit Breakers
Earth Leakage Circuit Breakers
Miniature Circuit Breakers
Automatic Power Factor Correction Equipment
Busway termination

.2. Indicate on shop drawings:

.1. Floor anchoring method and foundation template.

.2. Dimensioned cable and bus duct entry and exit locations.

.3. Dimensioned position and size of bus.

.4. Overall length, height and depth of complete switchgear.

.5. Dimensioned layout of internal and front panel mounted components.

.3. Indicate on product data:

Time current characteristic curves for all circuit breakers.

1.5 FACTORY TESTING

.1. Refer to Section 16010.

.2. Notify the inspection team 4 weeks in advance of final factory tests of the switchboards. The inspection team shall be entitled to witness all or any of the factory tests.

.3. Submit copies of certified test results.

PART 2 PRODUCTS

2.1 REFERENCES

.1. Refer to Section 16100 Basic Materials and Methods.

.2. Refer to Section 16115 Busways.

.3. Refer to Section 16450 Grounding.

2.2 SLEEVES FOR PRIMARY SERVICE CABLES

.1. Heavy duty treated flanged metallic sleeves complete with all required fittings and bell end terminations, as shown on drawings and satisfying the requirements of authorities having jurisdiction.

2.3 380/220 VOLT SWITCHBOARDS

.1. Provide switchboards as specified hereinafter and as detailed on the drawings.

.2. General Switchboard Criteria.

.3. Switchboards shall be 400/220 volt, 3 phase, 4 wire 50 cycle AC, IP 42, metal enclosed for use on solidly grounded systems. The switchboard shall be in accordance with BS 5486: or equal to IEC 439-1 and having a minimum class 3 protection IP-42. The switchboards shall incorporate all of the following:

.1. Air circuit breakers up to 3500 amps complying with IEC 947 and as specified hereinafter.

.2. Current limiting and standard type non-fused moulded case circuit breakers and as specified hereinafter.

.3. Tested to ASTA certification IEC 439-1 or BS 5486 for a fault rating of 50 KA for 3 secs at 380 volts or 100 KA for 1 sec. The ASTA certification or equal shall be valid for switchboard sections as well as field assembled complete switchboards.

.4. Tin plated copper bus bars.

.4. Casings & Enclosures

.1. All switchboards shall be of indoor construction, dead front, metal enclosed multi-cubicle type, free standing, dust and vermin protected, front operated and of clean and modern appearance. All equipment shall be completely enclosed and the construction of each cell shall be in such a manner as to permit front and rear access to the interior of any cell by isolating the particular switch.

.2 All switchboard sections shall be assembled and co-ordinated by one manufacturer. Main switch boards; motor control centers; owner equipment boards and motor control panels used for four pumps and above are to be Form 4, Type 6. Provide mimic diagram on the facia of the switchboards. Indicating lamps shall be LED type and provide lamp test button. Provide audiovisual alarm for trip indication with mute button. Space heaters shall be provided with humidistat and thermostat control , on/off switch and indicating lamp.

.3. The main switchboard sections shall be completely made of folded steel construction, minimum 2 mm thickness, fully rustproofed and epoxy powder painted inside and outside. Any sheets not painted or any other materials such as Alu.Zinc

etc. shall not be acceptable. Overall maximum height shall not exceed that shown on the drawings.

.4. All external bolts or screw heads shall be brass or cadmium plated, complete with required washers.

.5. All doors and removable covers or plates shall be provided with high quality neoprene gaskets to prevent the ingress of dust, vermin and insects. Doors shall have key type locks for faster open/close but not screws/bolts.

.6. All switchboard sections shall be of IP 42 construction in accordance with IEC 439.

.7. Each unit of the switchboards shall be housed in its own cell fittings with a hinged door mechanically interlocked in such a manner that the cell door can only be opened when the switch is in the 'OFF' position.

.8. Switching units shall be arranged in separate compartments or sections to protect against accidental contact with adjacent equipment when handling the elements in the section and to prevent the spreading of faults from one section to the other. Bushings shall be provided for all outgoing cables including control and BMS cables.

.9. Adequate cable ways shall be provided in switchboards accessible by hinged lids or removable covers. Arrangement shall be such that maximum accessibility is provided to all parts, incoming and outgoing wires and cables. They shall be factory assembled.

.10. The equipment in switchboards shall be accessible with indicating instruments mounted not higher than 1.8m and the centre lines of operating devices not higher than 1.8m above switchboard base. Drawout breakers (400amps and above) mounting height shall not exceed 1.4m from FFL. Switchboards shall be properly fixed to the floor with foundation bolts grouted in the floor / fixed to channel on trench wherever trench is available.

.11. All switchboards shall have top or bottom cable/busduct entry as required. Basically main incoming cables shall be bottom entry and outgoing cables or busducts top entry, through suitable termination boxes and gland plates, all accessible from front or rear of panel. The Contractor shall ensure that adequate access and termination provision is incorporated in complete switchboards for all incoming and outgoing cables and busducts specified.

.12. All panels and equipment shall be certified typed-tested, suitably rated for operation in the ambient conditions and supply characteristics stated.

.13. Switchboards sections shall contain withdrawable type air circuit breakers, busbars, MCCBs, instruments, earth bus, etc., as specified with ratings and arrangements as shown on the Drawings and shall be complete with all internal wiring and connections.

.14. All switchboards shall be tested at the manufacturer's premises as well as after installation.

.15. The Contractor shall submit all technical details, wiring diagrams and interlocking arrangements to the Engineer for review prior to ordering. Detailed constructions and general arrangements shall be agreed with the Engineer during construction stage.

.16. All doors and removable covers shall be provided with a flexible earth conductor connected to the switchboard frame.

.17. BMS marshalling compartment of adequate size shall be provided in every switchboard and motor control centre wired to units.

.18. Battery and battery chargers for the control of PLC's and breakers shall be provided with 100% redundancy in separate enclosures with all failures, overcharge, under voltage, overvoltage alarms being monitored by BMS.

.5 Busbars

Main bus bars shall be constructed of high strength, high conductivity, flat tin plated hard drawn copper throughout, fully braced by means of colour code injection moulded glass filled polyester insulation with joints bolted using high strength 12mm cadmium plated steel bolts and extra wide, extra thick washers to ensure maximum pressure and current distribution at each joint or fully insulated with colour coded fire retardant insulation. Bolts shall be tightened to torque wrench prescriptions.

The busbars shall be designed so that maximum temperature rise in any part of the switchboard will not exceed 35 degree C over 50 degree C ambient at full load. Reduced size neutral busbars shall not be permitted. Bus bars current density shall not be less than 1000 A/Sq. inch. 'T' type connection units shall be used for connection between main busbars and branching busbars. Busbars end shall be tinned. Compartment temperature rise shall be within the limits to comply with latest BS / IEC Standards.

.6 Ground Bus

A continuous ground bus, not less than 50% of the main bus cross section area shall be provided for the length of each switchboard and solidly bolted to the steel framework. The ground bus shall be constructed of the same materials as the main bus and shall be complete with suitable lugs for grounding connections outlined on the drawings. The ground bus shall have momentary current rating equal to or greater than that of the apparatus in the switchboard. Removable link is required between the neutral bus and ground bus .

.7 Control and Instrumentation Wiring

.1 Control wiring will be with PVC insulated stranded copper conductors rated for 750V and 90 Deg. C.

.2 Connectors to be vinyl insulated compression terminals manufactured in one piece from pure electro tin plated copper. Insulation to be colour coded with separate colours for the following applications:

.1 380 volts.

.2 220 volts.

.3 Run wiring from current transformer to instruments or relays via terminal blocks with shorting links for maintenance. CTs for transducers shall be separate. CTs or PTs used for metering protections, signaling, interlocking shall be separate and shall not be used for multi-purpuse.

.4 Identify all wires at each end with wire tags. Wires in all switchboards to have a unique identification.

.8 Digital Metering System

A digital metering system complete with all CTs and PTs for customer's use shall be installed and factory wired in locations in each switchboard as specified hereinafter. All PT

secondaries shall be for 24V, and all CT secondaries shall be 5A. The system shall be an integrated micro-processor based metering package, capable of displaying phase voltage, line volts for all phase , current for each phase, power factor, frequency, kilovolt amperes, kilovolt amperes reactive, kilowatts , Kilowatts hours, megawatt hours, , maximum kilowatts demand, and display overflow. A standard banan jack test block shall allow testing of the meter by injecting 220V and 5A while the phase display indicates T. Three set point dry contacts for load shedding or alarm shall be provided, each being field programmable to suit Employer requirements. The meter shall be designed to include provisions for communication with external monitoring devices via an RS232C port or better. All parameters shall be available on LCD display only by selection button provided on meter.

The metering system and associated software shall be manufactured by the switchboard manufacturer.

The Contractor shall include for all hardware and software as required and recommended by the meter manufacturer for remote monitoring at the BMS terminals for kilowatt-hour meter readings and failure alarm.

.9 Switchboard Arrangements

.1 Generally switchboards shall be as specified hereinafter. Specific items of equipment of each switchboard shall be as detailed on the drawings and as listed hereinafter.

.1 A PLC alarms shall be monitored by BMS including battery alarms.

.2 Logic sequence of operation shall be as shown on drg. no. LITE/LSCH/L-47 achieved through the PLCs with 100% redundancy and auto changeover interconnected with the generator switchboard PLCs.

.2A Sealed batteries and charger with four hours back up power and 10 years guaranteed batteries shall be installed in separate enclosure. Provide digital ammeter , voltmeter and boost switch for battery charger. Batteries shall be monitored at BMS for common fault, charger trouble, low battery voltage and earth fault.

3 All MDBs

.1 Incoming breakers controlling incoming service motor operated, withdrawable air circuit breaker, communicating type.

.2 Incoming breaker controlling generator service shall be motor operated, withdrawable air circuit breaker, communicating type.

.3 Feeder circuit breaker serving bus risers shall be motor operated withdrawable air circuit breaker communicating type.

.4 Other outgoing feeder breakers shall be of withdrawable moulded case circuit breakers sized as detailed on the drawings with a minimum short circuit interrupting capacity of 50 KA RMS system at 380 volt 3 phase, communicating type.

.5 Digital metering units located as shown on drawings.

.6 Ground fault relays and CT's.

.7 All MCCBs shall be solid state communicating type.

.8 Kilowatt Hr meters as shown on drawings.

.9 Lamp test buttons

.10. Buzzer with mute for mains presence. One button for each group to mute all buzzers.

.11 Transformer failure simulation switches in addition to one simulation switch for total mains failure.

.4 Low Voltage Motor Control Centre

1. Scope

This specification covers design, engineering, assembly works testing of low voltage Motor Control Centres for Modern high rise building complexes. The Motor Control Centre shall provide power and centralized control for Air Conditioning equipment drives in the building/complex. As such high reliability and continuity of supply / service are prime requisites. Refer also section 16800.

2. Ambient Conditions

Max. ambient temperature	50°C
Max. RH	100
3. System Voltage	380V/220V, 50Hz 3 phase 4 wire

4. Standards

Equipment offered shall conform to the latest issue of following standards:

BS 4752	ACBs & MCBs
BS 3871	MCBs
BS 589	Direct Acting Meters
BS 1650	Capacitors for PF connection
BS 4941; 1-4	Motor Starters
BS 5424	Contactors
BS 5420	Degrees of protection of enclosures

In addition to the above the switchgear equipment shall conform to local regulations.

The Switchboard shall be of simple, yet robust modular construction providing a factory built assembly for use as a combined Power and Motor Control Center (PMCC).

It shall be floor mounting free standing sheet steel clad modular pattern Cubicle type

ASTA certified for 50 KA at 380V for 3 secs.
Manufactured to BS5486: Part 1: 1986, Form 4 Type 6 or IEC 439-1
Dead front design
Top and / or bottom cable entry
Front and / or rear access for cabling
Degree of Protection IP54

5. Indication & Controls

All indication and controls shall be grouped together on the front of the ACBs and shall be accessible on the front door of the Cubicle through a suitable cut out on the cubicle door. The arrangement shall be flush, neat aesthetic and modern.

The item shall generally comprise;

- Manual Spring charging lever
- Indication of spring charged - yellow

- Indication of Circuit breaker - Tripped
- Closing Push Button
- Opening Push Button
- Open / Closed Indication of ACB
- Racking in/ out device with door closed
- Release lever for moving part of ACB
- Service/Test/Isolator Position indicator
- Lamp test button.
- Microprocessor based control with LCD display and all adjustable settings displayed.

6. Safety Shutters

Withdrawable ACBs shall be provided with shutters that drop automatically on withdrawal. Shutters shall be RED with markings to show live contact are behind the shutters. Shutters shall have padlocking facility.

7. Safety Interlocks

A lever shall be provided on the front of the ACB which shall be released to withdraw or insert the moving part. It shall not be possible to rack In or Out a closed ACB.

8. MCCBs

MCCBs shall be three pole manually operated fixed type with thermo magnetic releases for overload and short circuit. Breaking capacity shall not be less than 25KA at 380V, 50Hz where 50 kA is not specified.

9. Starter Feeders

Each starter feeder shall be equipped with but not limited to:

- Main TP MCCB with door interlocked rotary handle
- Triple pole thermal overload relay with built in single phasing prevention feature, 2 auxiliary contacts for remote monitoring.
- Hand-Off-Auto Control Switch
- Common Duty Selector Switch where applicable
- Run/Trip Lamps
- Digital Ammeter with selector switch
- Auto changeover key operated arrangement where applicable
- Wiring for interlocking with Chiller Control Circuit
- Chillers sequence and selector controls if required/as shown on the drawings.

Earth bar shall be of minimum 300sq mm^2 and run the entire length of the switchboard.

10. Interconnections

Interconnections shall be very short and neat using air insulated, tinned copper bars.

11. Termination

Unless otherwise indicated, cable entry shall be from bottom only, cabling access is from the front or rear as applicable. A platform shall be built within mechanical room to elevate MCC's and allow bottom entry and easy access to compartments.

For large power feeders suitably staggered links shall be brought out into the cabling area for easy termination of cables of sizes as shown on the drawings.

For Starter feeders power and control cables shall be brought out neatly to terminal blocks. Power and Control terminals shall be adequately segregated. Power wires shall be RYB colour coded at the termination's. Control wires shall be multi stranded copper with black insulation and ferruled. Terminal Blocks should be suitably marked for identification and easy termination of field wires.

12. Meters shall be multi function digital type. Indicating lamps, push buttons control and selector switches shall be neatly and logically flush mounted on the front of the respective equipment compartment doors to IP54. Lamp test button shall be provided.

13. ACBs

ACBs shall be of modern, advanced design and construction, modular pattern with features for high breaking capacities, precise control, indication and protection. They shall be motor operated 3 or 4 pole as specified on the drawings / schedules, and shall be of communicating type similar to MDB's Breakers with IP-54 covers.

14. Protection - Direct acting built in, solid state microprocessor (micro logic) based releases shall be provided for protection against Overload, short circuit and earth fault. Under voltage trip and shunt trip shall be provided. LCD display for reading all parameters is required. The activated protection also shall be displayed or indicated.

- Overload stage shall comprise an inverse Long Delay unit with settings from 0.4 to 1 x In, on 5 different characteristics curves.

- Short Circuit Stage - Inverse short delay unit adjustable from 1 to 8 x In definite steps on 7 different characteristic curves with adjustable time lag settings. The protection specified is applicable for all ACBs of Section 16400 & 16622 and 16800.

- The trip unit of ACB shall provide measurement of current, voltage, active power and harmonics (3, 5, 7, 9, 11 & 13). These shall be displayed on LCD screen. The trip unit shall also display histories of last 10 trips and maintenance indicator.

15. Operating Mechanism

The ACB shall be closed and opened by a Stored energy spring charged operating mechanism. Closing springs shall be charged by motor operated with also provision for manual charging .

16. Construction

The switchboards shall be constructed with 2mm-thickness sheet steel and of epoxy powder painted colour RAL7032. These frames shall be fitted with gland plates or cover plates depending on the cable entry. The top frame with provision of fitting lifting eye-bolts and the bottom frame with mounting holes for fixing to foundation bolts.

Functional units shall be mounted in multi tier modular assemblies / compartments that are prefabricated to accept the complete range of manufacturers products. Minor adaptations to the mounting assemblies shall enable a host of other products to be mounted.

Mounting assemblies, together with their functional units shall be bolted to the basic structure, which is also modular. The basic structure shall be 16 modules high and capable of accepting mounting assemblies that are in multiples of a basic module.

The Compartment front doors shall be folded at the edges and welded at the corners with concealed hinges and with rotary front operating handles accessible externally. Side and rear covers shall completely enclose all live parts and complete switchboard shall present a neat flush and aesthetic appearance.

17. Paint Finish

All steel work shall pass though a four stage finishing process, chemical spray, degreasing, iron phosphating and finally an electrostatically applied top coat of epoxy powder coating which is cured in a high temperature over to give a strong molecular bonding with the steel. The top coat shall be RAL7032 colour.

18. Busbars

The Main Horizontal busbars shall be HDHC tinned insulated copper with phase colour sleeved running in the full switchboard. Current rating as shown on the drawings rated for the ambient specified. Supports shall be fibre glass reinforced, moulded type material with large creepage paths or as recommended by the manufacturer. They shall be totally enclosed in a separate sheet compartment and braced for the fault level specified. Temperature rise as specified earlier in this section.

The vertical busbars shall also be HCHC tinned insulated copper, suitably connected to the Main Horizontal busbar and run in a separate totally sheet steel enclosed Vertical busbar chamber. The busbars shall be supported regularly at short intervals by fibre glass reinforced moulded type material or as recommended by the manufacturer. Current ratings shall suit the loads connected on each Vertical busbar.

The Horizontal and Vertical busbars shall be ASTA Certified or equal for Specified fault level .

Neutral shall be of same size as the phases for Horizontal and Vertical busbar assemblies and sleeved completely black.

.5 Air Circuit Breakers

.1 Air circuit breakers as listed in the switchboard arrangements shall conform to IEC 947-2 and shall be as specified hereinafter.

Air circuit breakers shall be supplied from an approved manufacturer with a solid state microprocessor based release adjustable type, instantaneous short circuit protection, adjustable earth fault protection, excess temperature and built-in release malfunction alarm. The microprocessor shall enable building management system to monitor and control the air circuit breaker. Provide LCD display for reading all parameters.

.2 Low voltage power air circuit breakers shall be 3 or 4 pole (as indicated in the drawing) 600/1000-volt class with continuous current ratings and trip ratings as detailed on the plans. Breakers shall be rated for 65 KA interrupting capacity at 380 volt 3 phase for 3 seconds unless otherwise indicated. Breakers shall have double break main contacts, a 3 phase solid state overload relay, earth fault relay

and shall be trip free in operation. Under-voltage and shunt trip release shall be provided. A compression spring stored energy in closing mechanism (electrically charged) shall be used for all ratings, with breakers being closed by means of a push button and shall have the ability to close and latch at interrupting rating at 600 volts. An emergency manual spring charging handle shall be supplied for electrically operated breakers. Handle shall be flush with the front panel of the air circuit breaker in the stored position.

.3 Breaker faceplate shall have "closed-open" indicator, spring "charged-discharged" indicator, provision to padlock manual charging handle, provision to lock breaker in "open" position, and provision to lock drawout mechanism. Drawout circuit breakers shall be suitable for 3 position (connected, test, disconnected) racking with enclosure door closed, and shall be equipped with an interlock to ensure breaker contacts are open and closing spring is discharged when racking tool is inserted. Faceplate mounted control buttons indicators interlocks etc. shall be accessible without opening enclosure door.

.4 Electrically operated breakers must have provision for emergency manual closing by inserting a special tool through the faceplate. A control isolating switch shall be provided on the faceplate to isolate the supply to the spring charging motor.

.5 Relay pick-up and time delay settings shall be selected in discrete factory calibrated values by means of detent action thumbwheel actuated switches with gold-plated contacts. The relay shall be equipped with Zone Selective Instantaneous Protection feature on short time and ground fault elements. A direct acting dedicated solenoid shall be used for initiating breaker tripping. All ACB's shall be provided with auxiliary contacts for local and remote trip alarm annunciation.

.6 All bus couplers shall be drawout type manually operated ACB with overload, short circuit and earth fault protections and shall be mechanically and electrically interlocked as shown on drawings. Removable links shall be provided in the main bus bar of each phase immediately after the incoming ACBs to enable easy maintenance and replacement of current transformers of the measuring instruments.

.6 Moulded Case Circuit Breakers

.1 All breakers shall be of the same switchboard manufacturer and standard ratings and frame sizes shall be used where appropriate and possible.

.2 Moulded case circuit breakers shall be of the air break design type, quick make and quick break, having free toggle mechanism ensuring full contact pressure until time of opening, whether actuated automatically or manually. The mechanism shall be completely enclosed in a compact moulded Bakelite case, sealed to prevent tampering. Breakers shall be drawout type for MDBs and MCCs and plugin / screw on type for OEBs and SMDBs.

.3 Circuit breakers shall have inverse time tripping characteristics with automatic release secured through action of a combination thermal magnetic trip element which shall trip free of the handle and operate in response to an overload or short circuit. Provide MCCB with adjustable overload and short circuit protections

.4 Breaker contacts shall be non-welding and non-corrodible silver tungsten composition. Circuit breaker handle shall have three positions, 'OFF', 'ON' and 'TRIP' thus indicating clearly abnormal conditions of the circuit. Single pole circuit breakers with handle tie or bar equivalent construction are not acceptable for a multi-pole breaker. Breakers shall have ratings and breaking capacity as indicated on the Drawings.

.5 All circuit breakers shall be as indicated under the section of the documents and as drawings. All circuit breakers feeding motors shall be of motor protector type suitable to withstand the motor starting current at the full load current trip setting.

.6 Current limiting circuit breakers shall be no fuse type and shall be used, as specified elsewhere on the distribution system to ensure that fault levels are restricted to acceptable levels for downstream devices and equipment. The characteristics of all current limiting breakers shall be submitted to the Engineer for review.

.7 MCCBs shall be provided with padlocking in the 'OFF' position and shall be fitted with shunt trips/undervoltage trips as required for proper operation and two sets of N/O and N/C auxiliary contacts.

.8 Where indicated moulded case circuit breakers shall incorporate earth leakage sensors as detailed to trip the breaker and provide an alarm (except for fire pumps). The sensitivity setting of the sensors shall be as detailed on the drawings.

.9 All MCCBs shall have the capability of communicating with the BMS. Where indicated on the drawings or BMS schedule (Sections 15900 & 15950), MCCB's shall be monitored/controlled as shown therein.

.10 MCCB's 100A and above shall be solid state communicating type for MDBs, MCCs, OEBs & SMDBs.

.7 Outgoing Circuits and Connections

.1 All outgoing circuits shall have separate compartment and/or be screened so that equipment for any one circuit can be maintained without risk of contact with live connections on any other circuit, conforming to IEC 60439 form 4 type 6(c).

.2 Feeders for circuits rated up to 63A shall be connected to terminal blocks located in separate compartments at top or bottom, conveniently arranged to facilitate termination of cables and suitably identified.

.3 For feeders rated more than 63A copper links shall be suitably extended rigidly supported and covered with coloured PVC sleeves.

.4 All feeders shall be provided with cable lugs and brass cable glands.

.5 Vermin barrier and removable gland plates suitable for the glands required for the specified cables shall be provided. Where cables are single core, the gland plates shall be of a non-ferrous metal.

.6 Bushes shall be provided at every compartment for outgoing cables.

.8 Cable and Busbar/Busduct Interconnections

.1 The Contractor shall supply and install all cable and busbar interconnections indicated on the Contract Documents and/or required for correct operation of the equipment.

.2 All cables must be in accordance with specification section 16120.

.9 Cable Glands

.1 Each panel sections shall be provided with cable glands to suit the type, size and number of low voltage cables as indicated on the Drawings.

.2 Provision shall be made for future additional cabling.

.3 Cable glands or brackets where required shall be mounted inside the panel. Sufficient space for cable connections and adjustments on site shall be provided.

.4 The Contractor shall supply approved bolted type compression terminals or equivalent for external cable connections.

.5 All openings for external cable connections shall be suitably protected to prevent ingress of dust, vermin etc.

.6 The panel sections shall be provided with proper cable fixing clamps and sweating terminal lugs as well as bonding connections.

2.4 DISTRIBUTION PANELBOARDS (SUB MAIN DISTRIBUTION BOARDS)

.1 a) Distribution panel boards shall be manufactured in accordance with IEC 60439 form 2B type 2 and shall be ASTA certified to 35 KA RMS symmetrical for one second. Provide dead front for outgoing breakers. Incomer shall be provided with operating handle. Ambient temperature 50 degree C.

b) Owner equipment board shall be manufactured in accordance with IEC 60439 Form 4 Type 6 and shall be ASTA certified to 35KA RMS symmetrical for one second. Thickness of sheet 1.6mm epoxy powder painted colour RAL 7032 inside and outside.

.2 Panel boards shall be factory assembled floor mounted type. Moulded case circuit breakers shall be provided to withstand a fault level of 35 KA at 380 V, 3 phase, 50 Hz. Moulded case circuit breakers shall have adjustable overload and short circuit protections. All MCCBs shall be solid state type. Panel boards shall have at least 10% spare circuits.

.3 Panel board Constructions.

.1 Panel boards shall have 1.6 mm zinc coated sheet steel and all items shall be flush mounted in the panel. Unless otherwise specified all panels shall be so designed and constructed that all cable installation and connections, and maintenance including the replacement of any item, can be carried out from the front. Panel shall be manufactured in accordance with IP 42. Provide dead front for outgoings.

.2 All connections between bus bars and any incoming or outgoing protective devices shall be made using copper bar or cable. All items comprising the panel shall be so segregated that maintenance, other than to bus bar connections, can be carried out on any one item without disrupting the supplies fed by other items. The whole panel shall be finished in epoxy powder coating RAL 7032.

.3 The front face of such panels shall comprise a lockable gasketed hinged door. All internal connection cables shall be fitted with identity sleeves and all terminals with identifying tabs. The markings for identifying sleeves and tabs shall be shown on all shop and record drawings.

.4 A main earth terminal shall be provided on all panels, the metal framework and casing of any type of panel shall be bonded together and to the main earth terminal of the panel by means of copper earth conductor of adequate size.

.5 All panel boards shall incorporate an earthing terminal busbar sized to accommodate earth continuity conductors for each single pole, or multipole MCCB way, plus a minimum of five additional terminals for supplementary earth bonding conductors of minimum 16mm sq. size.

.6 Removable gland plates shall be provided at the top and bottom of all panel board enclosures for raceway termination and or cable gland termination. Where cables are single core, the gland plates shall be of a non-ferrous metal.

.7 Where contactors are incorporated in panel boards, these shall be located in a separate compartment from protective devices, and have hinged lockable door access and means of ventilation.

.8 Low voltage LED pilot lights shall be provided to indicate phase live conditions.

.4 Panelboard Busbars

.1 Busbars shall be electrolytic hard drawn copper to BS 159 and tin plated with rating as indicated on the drawings, air insulated and rigidly supported by suitable non-hygroscopic, anti-tracking insulators so as to withstand forces due to thermal expansion under normal operating conditions and the fault currents at the point of installation, neatly arranged for 380V, 50 Hz, 3 phase, 4 wire operation, and fault rating not less than 35 KA sym. for 1 seconds. Busbars shall be designed for 35°C temperature rise above an ambient temperature of 50°C.

.2 Busbars shall have the same cross section throughout.

.3 Busbars bracing shall maintain the same mechanical strength and current carrying capacity under normal operation conditions and fault conditions.

.4 Busbars shall be colour coded.

.5 Busbars shall not be exposed unless the complete panelboard doors and dead front is removed.

.5 Moulded Case Circuit Breakers

.1 All breakers shall be of the same manufacturer and standard ratings and frame sizes shall be used where appropriate and possible.

.2 Moulded case circuit breakers shall be air break deion type, quick make and quick break, having free toggle mechanism ensuring full contact pressure until time of opening, whether actuated automatically or manually. The mechanism shall be completely enclosed in a compact moulded bakelite case, sealed to prevent tampering. Breakers shall be plug in / screw on type.

.3 Circuit breakers shall have inverse time tripping characteristics with automatic release secured through action of a combination thermal magnetic or hydraulic magnetic trip element which shall trip free of the handle and operate in response to an overload or short circuit.

.4 Breaker contacts shall be non-welding and non-corrodible silver tungsten composition. Circuit breaker handle shall have three positions, 'OFF'. 'ON' and 'TRIP' thus indicating clearly abnormal conditions of the circuit. Single pole circuit breakers with handle tie or bar equivalent construction are not acceptable for a multi-pole breaker. Moulded case circuit breakers shall be Plug-in type. Breakers shall have ratings and breaking capacity in accordance with the Contract Documents.

.5 Moulded case circuit breakers shall withstand a fault level of 35 KA at 380 V, 3 phase, 50 Hz.

.6 Current limiting circuit breakers shall be no fuse type and shall be used on the distribution system as specified elsewhere, to ensure that fault levels are restricted to acceptable levels of downstream devices, equipment and branch circuit panelboards. The characteristics of all current limiting breakers shall be submitted to the Engineer for review. The contacts shall be opened before the crest current value of the unrestricted short circuit current is reached.

.7 MCCB's shall have padlocking in the 'OFF' position and auxiliary contacts, shunt and under voltage trips for proper operation. Provide a minimum of two sets of N/O and N/C / auxiliary contacts.

.8 Where indicated moulded case circuit breakers shall incorporate earth leakage sensors as detailed to trip the breaker and provide an alarm (except for fire pumps). The sensitivity setting of the sensors shall be as detailed on the drawings.

.9 All MCCB's shall be adjustable overload and short circuit setting type.

.6 Digital voltmeter and digital ammeter with selector switches: 0-500V voltmeter with selector switch. Ammeter complete with selector switch and CT's with links for maintenance.

2.5 FINAL DISTRIBUTION BOARDS

.1 Factory assembled Final distribution Boards as scheduled on the drawings and as specified hereinafter to BS5486 Parts 12 1986 with IP42 degree of protection. Enclosure including all other internal sheets shall be sheet steel 1.4mm thick minimum with epoxy powder paint inside and outside and colour shall be RAL 7032. Type of mounting flush or surface shall be agreed with the Engineer during construction stage.

.2 Panel board Enclosure Provisions

.1 Panel boards shall have sheet metal cladding and all items shall be flush mounted in the panel. Unless otherwise specified all panels shall be so designed and constructed that all cable installation and connections, and maintenance including the replacement of any item, can be carried out from the front. Panel shall have dead front.

.2 All connections between bus bars and any incoming or outgoing protective devices shall be made using copper bar or cable. All items comprising the panel shall be so segregated that maintenance, other than to bus bar connections, can be carried out on any one item without disrupting the supplies fed by other items. The whole panel shall be finished epoxy powder paint colour RAL7032.

.3 The front face of such panels shall comprise a lockable hinged door. All internal connection cables shall be fitted with identity sleeves and all terminals with identifying tabs. The markings for identifying sleeves and tabs shall be shown on all shop and record drawings.

.4 A main earth terminal shall be provided on all panels. The metal framework and casing of any type of panel shall be bonded together and to the main earth terminal of the panel by means of a copper earth conductor of adequate size.

.5 All panel boards shall incorporate an earthing terminal busbar sized to accommodate earth continuity conductors for each single pole, or multipole MCB way, plus a minimum of five additional terminals for supplementary earth bonding conductors of minimum 16mm sq. size.

.6 Removable gland plates shall be provided at the top and bottom of all panel board enclosures for raceway termination and or cable gland termination. Where cables are single core, the gland plates shall be of a non ferrous metal.

.7 Final distribution power boards should be supplied with clear space between edge of outgoing breakers and side of panel minimum 200mm. for wiring. This clear space for wiring shall be available on both sides of the boards. Standard panels are not acceptable.

.3 Panelboards Busbars

.1 Busbars shall be electrolytic hard drawn copper to BS 159 with rating as indicated on the drawings, air insulated and rigidly supported by suitable non-hygroscopic, anti-tracking insulators so as to withstand forces due to thermal expansion under normal operating conditions and the fault currents at the point of installation, neatly arranged for 380V, 50Hz, 3 phase, 4 wire operation, and fault rating minimum 10 KA symmetrical.

.2 Busbars shall have the same cross section throughout.

.3 Busbars bracing shall maintain the same mechanical strength and current carrying capacity under normal operation conditions and fault conditions.

.4 The bus bar system shall be capable of accepting 3 phase or 1 phase plug-on MCB's.

.5 Earthing terminal bus bar to be provided.

.4 Miniature Circuit Breakers (MCBs)

.1 Miniature circuit breakers shall comply with IEC-60898 have a rated trip type B or C (type 2 or 3) as required by the drawings and shall have a minimum breaking capacity of 9KA. The frame size of all MCBs shall be the same so that they can be easily interchanged. Breakers can be either plug on type or screw-on type . Circuit breaker devices shall be of the trip free pattern to prevent closing the breaker on a fault and shall be engraved to indicate 'ON' and 'OFF' positions.

.2 MCBs shall be so arranged in the board that it shall be possible to replace a triple pole MCB with three adjacent single pole MCBs or vice versa. The boards shall be surface type unless indicated otherwise on the Contract Documents. Cable glands shall be provided where required.

.3 All MCBs shall ensure protection against sub-circuit overloads by means of ambient temperature compensated thermal overload trips for ambient temperature 50 Deg. C and against short circuits by instantaneous magnetic overload trips.

.4 Multi-phase MCBs shall so designed that if more than one trip mechanism operates, all poles shall open simultaneously. Three pole devices shall be installed for three phase supplies.

.5 Particular attention shall be paid to the utilization of MCBs in respect of system characteristics, such as fault capacity and discrimination protection, and where appropriate sizes or rating are not specified, it shall be the responsibility of the Contractor to ensure the correct type of equipment is installed and to submit his proposals to the Engineer for review before any equipment or materials are placed on order.

.6 All MCBs shall be clearly engraved to indicate the particular current rating.

.5 RESIDUAL CURRENT DEVICE (ELCB) for FDBs

.1 For all circuits serving socket outlets in the floor screed, either in the under floor duct system, the in floor outlet boxes or under the raised floor and where indicated on drawings provide residual current device (ELCB) type circuit breakers unless otherwise indicated.

.2 Breakers shall comply with BS4293 (1993).

.3 These breakers shall be all insulated type and consist of a current transformer, tripping coil and contact, 'ON'/'OFF' trip free front operated handle and a test push button. The tripping mechanism shall cause interruption of the supply on an earth fault current of 30 milliamps or 100 m amps or adjustable as shown on the drawings. The tripping arrangement shall not be affected by ambient temperature changes. The current carrying contacts shall be of robust construction, made of suitable copper alloy and they shall be non-welding and self-wiping.

2.6 PLANT AND FIELD TESTS:

Factory test all switchgears in accordance with ASTA Standards. Submit completed sheets for each switchboard to the Engineer for approval. Include approved field test sheets in the Operation and Maintenance Manual.

2.7 SWITCHGEAR COMPONENTS FOR MDBS, MCCS, SMDBS, OEBS AND ALL OTHER CONTROL PANELS.

.1 A.C. Contactors

.1 Magnetic full voltage contactors, heavy duty, non-reversing type for heating, motor loads and lighting loads. Each contactor shall be suitable in all respects for the application and shall be recommended type for its breaker shall be AC-23 duty type to IEC 60947-4.

.2 Mount each contactor in an enclosure, complete with the necessary accessories including pilot light in cover.

.3 The amperes rating number of poles, auxiliary contacts etc., for contactors shall be as noted on the drawings and as required by equipment manufacturer.

.4 Contactors shall have CE, CSA and UL approvals .

.2 Earth Leakage Circuit Breaker (Relays)

.1 Relays shall have power green ON led, red trip LED, test button , reset button, LED s for pre warning of leakage current at early stage. 2 change over contacts.

.2 Setting range (sensitivity) shall be 0.03, 0.1, 0.3, 1, 3, 5 amps.

.3 Time delay setting range 0.025, 0.5, 1, 1.5, 2, 2.5 seconds

.4 Pre warning LEDs for 15%, 30%, 45%, 60%, (yellow) and 100 %(red) of set sensitivity value

.5 Auxiliary supply voltage, DIN rail mounting /separate base will be as required to suit the board requirements. Provide clear glass window to see the relay. Relay shall be CE approved. Number of poles as indicated on drawings.

.3 Plug in type Power / Auxiliary Relays

.1 Relays shall have silver-nickel plated contacts. No of poles 2/3, 8/11 pins as required.

.2 Coil rating 24V/220V/110V as required. Contact rating 10 amps at 250 volts.

.3 Mechanical flag indication and latching feature.

.4 Operating temperature – 40 to +60 degree C . Electrical life shall be minimum 200, 000. IP40 degree of protection.

.5 DIN rail mounting /separate base mounting will be as required to suit the board requirements. Contacts shall be clearly visible. Relay shall be CE, CSA and UL approvals. Number of poles as indicated on drawings. Relay shall have manual operating button.

.4 Under voltage, Phase Failure, Phase sequence, Timer, Thermistor Relays

.1 Relays shall have power ON /trip LED.

.2 Setting range (sensitivity) as required.

.3 Time delay settings range as required.

.4 Supply voltage, DIN rail mounting /separate base will be as required to suit the board requirements. Ambient temperature –290 to +60 degree C. Relays shall be CE approval.

AUTOMATIC POWER FACTOR CORRECTION EQUIPMENT

Provide automatic power factor correction equipment to improve the power factor at the main switchboards to a min. of 0.95. The system shall automatically switch predetermined steps of capacitor banks as programmed in the controller and be integrated in the main switchboards.

Provide a detailed calculation to show the required capacity based on selected and approved equipment electrical loads.

The design, construction and installation of the automatic power factor correction equipment shall meet the requirements of the latest editions of CSA C22.1, C22.2, No. 29 and No. 190.

.1 Capacitors

The three phase capacitor cell shall be constructed of metallized polypropylene vacuum impregnated with NON-PCB oil, in a one piece extruded aluminium housing complete with integrated grounding/mounting stud. Capacitors to be self-healing type . Temperature range from -25^{O}C to +55^{O}C as per IEC 831-1 & 2. Losses to be less than 0.2 W/kVAr.

.2 Capacitor Steps

All rack mounted capacitor modules to be equipped with standard HRC Form 1 fuses, contactors approved for capacitor switching, current limiting reactors, distribution blocks, discharge resistors and capacitor elements. Capacitor bank to consist of CSA approved 15kVAr capacitor elements or higher up to 50 kVAr to form the required rating for each step unless otherwise requested by DEWA.

.3 Power Factor Controller

Controller, microprocessor based, to be self contained and mounted in door of enclosure. The controller shall continually measure the actual phase angles, current amplitude and retain installed kVAr step size to automatically switch capacitors on or off as required. Other features shall include:

A. automatic initialization of power factor controller (phase angle location),
B. automatic circular switching sequence (first step on is first step off),
C. digital adjustable setting and display of target power factor for 0.85 lagging to 0.96 leading,
D. digital display of power factor,
E. digital multiplier for switching time delay,
F. visual indication of capacitor steps energized,
G. visual indication of capacitive/inductive load,
H. manual operation (controller displays actual power factor),
I. zero voltage release.

.4 Packaged Capacitors

Three phase capacitors elements to be mounted in IP42 enclosure with 2mm thick sheet steel with epoxy powder coating inside and outside RAL7032 with provision for dust proofing, Elements shall be replaceable without removal of enclosure from job site. Main terminal or contactor shall be provided as specified. Panel shall be floor standing type. PFC enclosure for MCC shall be IP54.

.5 Current Transformer

Current transformer of proper rating to be supplied and installed by the manufacturer in their equipment.

.6 Ventilation fan with thermostat operation is required. Overheating alarm shall be wired to B.M.S.

2.9 RISER DIAGRAM

.1 Provide to the Employer 2 No. framed single line as built diagram of the electrical distribution system. Install in L.V. room and Generator house or as directed by the Engineer. Provide mimic diagrams on all MDBs , MCCs and OEBs.

PART 3 EXECUTION

3.1 ELECTRIC SERVICE

.1 Work to be undertaken by LESCO:

.1 Primary service cables (11KV) into the MV Switchgear Room by LESCO.

.2 MV Switchgear (RMU's) by LESCO in MV Switch room.

.3 MV Interconnecting cabling from LESCO Switch to consumer switch by LESCO.

.4 Secondary service cables (as per drawings) from the power transformer to the main switchboards.

.2 Requirements

.1 All work performed as part of this section for the electric service shall conform to all requirements of Electric Inspectorates.

.2 Make all required arrangements with the authorities, in order that the electric service is installed and put into operation at the proper time.

.3 Connection charges including material and labour costs of work classified under LESCO to be paid by client.

3.2 INSTALLATION OF SWITCHBOARDS

.1 Install switchboards as noted on the drawings and secure to a concrete housekeeping pad, unless the switch board includes its own metal base.

.2 Run grounding conductor 95mm^2 PVC copper in 50mm conduit from main ground bus to earth pits as per local authority requirements.

3.3 INSTALLATION OF DISTRIBUTION BOARDS

.1 Provide factory assembled MDBs, SMDBs, OEBs, FDBs and PFC banks as indicated on the drawings, each complete with panel board directories.

.2 Support cabinets and enclosures independent of connecting conduit and accurately install with reference to wall finishes.

.3 The Contractor shall include for all necessary brackets, angle iron frameworks, supports, etc., for fixing of panel boards. The Contractor's attention is specifically drawn in this respect to the need for frameworks where panel boards are mounted on dry lining stud partitions, where support frames shall fix to, and span between, vertical steel supports to partition lining.

.4 Equip panel boards with suitable lugs or provisions to accommodate the main and branch conductors scheduled.

.5 Turn over to the Employer upon acceptance of the project, 2 keys for every panel board complete with key rings, tags and key cabinets to the Engineer's approval.

.6 Where two (2) or more panel boards are installed in one (1) cabinet, equip the panel board with double lugs and increase gutter capacity to accommodate additional cabling. Busbars shall be rated for the combined current carrying capacity of the panel boards.

.7 On all flush mounted panel boards stub 2 - 50 mm empty conduits into ceiling space above panel board.

.8 Complete all panel board circuit directories to the Engineer's approval and mount it in a transparent enclosure at the back of the panel door.

.9 Fill in panel board directories using a typewriter, to identify circuits.

3.4 AUTOMATIC POWER FACTOR CORRECTION EQUIPMENT

.1 Set capacitor bank in place as shown on the drawings.

.2 Connect the feeder breaker CT's and PT's.

.3 Test the system before energizing the capacitor bank.

.4 Commissioning of the system to be as per the manufacturers recommendations.

.5 Demonstrate that the system is in perfect operating condition.

3.5 TESTING AND COORDINATION STUDY OF DISTRIBUTION

.1 Inspection Testing

.1 Include in the tender price the cost of on-site engineering inspection and testing of the following main distribution equipment.

Main Switchboards, M.C.C's OEB's, SMDB's MCP's, DB's
Emergency Generators.
Generator Switchboard and Synchronization Panel.

Extent of Testing & Inspection

.2 This engineering inspection and testing shall be done prior to the system being energized and shall include the following items where applicable.

.3 Testing, cleaning where necessary, and calibrating all relays and circuit breaker trip devices. (Calibration of all protective devices shall conform to requirements of approved co-ordination curves).

.4 Function test of associated control devices.

.1 Meggar test interconnecting cables.
.2 Carry out fault loop impedance test.
.3 Continuity of protective conductors.
.4 Earth resistance test.

.5 Carry out Thermography scan once at the end of construction period using a load bank up to 80% of rated capacity of bus ways and once during the maintenance period with anticipated available peak load of the building utilizing building load only..

.6 Preparation of testing, inspection and commission report on the function and operation of the automatic transfer switches associated with the emergency generator.

.7 An acceptance test in the presence of and satisfaction of the Employer and the Engineer.

.8 The presence, for the length of the required, or qualified and competent equipment service representatives during start-up.

.9 Forward for approval prior to energization of the distribution system and equipment, form neat typewritten copies of the engineering and testing report.

3.6 CO-ORDINATION STUDY

.1 The coordination study shall be carried out by switchgear specialist to ensure that full electrical power distribution system has proper protection devices to achieve proper protection and to isolate minimum possible faulty section from the system in case of any fault in any part of the power system. The study shall also ensure breakers can safely handle short circuit current derived at that point. KA rating and protections shown in the drawings or specifications are minimum requirements which shall be retained. But these values has to be varied and to be changed as per coordination study by contractor to the approval of Engineer before manufacturing the switchgear without any additional cost /time to contract.

.2 Carry out the following:

.1 Immediately upon award of the contract and prior to the manufacture of the switchboards, prepare a set of co-ordination curves on K.E. NO.336E time current characteristic graph paper and forward eight copies to the Engineer for his approval. Make any changes as directed by the Engineer at no additional charge to the Employer. Submit software copy for Engineer's review.

.2 This shall be accompanied by supporting symmetrical as well as asymmetrical fault current calculation data with tabulations to verify protection of the various elements of the system under maximum and minimum fault conditions at the various points in the system.

.3 The time-current characteristic curves for the following shall be plotted:

.1 The relays and breakers protecting the incoming service.

.2 Main and feeder protective devices at all voltage levels used in the distribution system.

.3 Protective devices associated with the largest motor in each MCC, the refrigeration compressor, and largest device in each distribution panel.

.4 Motor generator protective devices, damage areas and current decrement areas.

.4 It shall be the responsibility of the contractor to examine the plans and specifications to ensure that all the relays and protective devices being installed in the distribution system will provide satisfactory co-ordination.

.5 Breaker frame sizes, sensors, and delay types, shall be provided in accordance with the approved co-ordination study.

.6 Testing procedures shall be in accordance with the following Regulatory Authorities, British Standards Institution, Lloyds Registry, Veritos.

3.7 OWNER'S EQUIPMENT BOARDS

.1 Provide all Boards as shown on drawings or as provided as part of the work of other Divisions of the Specifications. The Owners equipment boards shall be Form 4 Type 6 unless otherwise indicated.

.2 Generally, unless otherwise noted, starting equipment, controls and accessories will be supplied by the supplier/installer of the apparatus. Obtain accurate "roughing-in" information to make all necessary "line" and "load" connections required.

.3 Be familiar with the apparatus being supplied by other divisions and carefully co-ordinate and co-operate with the supplier/installer to ensure a proper and complete installation.

3.8 TRAINING

Switchgear manufacturer shall provide training to Client's staff on various activities for a minimum period as shown against each item:

Generator Switchboard

Protection Scheme	4 hours
Synchronization / Paralleling	4 hours
Sequence of operation in relation with load shedding	8 hours
PLC Scheme / redundancy	8 hours
Battery / Battery Charger	4 hours
Preventive / corrective maintenance (Training should include tutorial + site visit)	4 hours

LV Switchgear / Busways

Power flow / Sequence	4 hours
Panel Construction Scheme (LV Panels, SMDBs, DBs)	4 hours

Major Component's construction / detail	3 hours
Components Inspection	2 hours
Preventive / corrective maintenance	3 hours
Busway – routine inspection	2 hours
Preventive maintenance	2 hours
Drawing formats	2 hours

(Training should include tutorial + Site visits)

Motor Control Center's / VFD's

Construction Scheme	2 hours
VFD – Basic theory / mode of operation	4 hours
Protection Scheme	1 hours
Components Inspection	2 hours
Preventive / corrective maintenance	3 hours

(Training should include tutorial + site visit)

Section-13: Busways

PART 1 GENERAL

1.1 General Requirements
1.2 Scope of Work
1.3 Quality Assurance
1.4 Submittals

PART 2 EXECUTION

2.1 Installation
2.2 Tests

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

1. The work of this Division shall be governed by the following documents:
    1. Conditions of Contract.
    2. Instructions to Tenderers.
    3. Form of Agreement.
    4. General and Special Conditions of Contract.
    5. Form of Tender.
    6. Appendices.
    7. Applicable Divisions.
2. Comply with requirements of all sections of this Division
3. It is the Contractors responsibility to be fully aware of and comply with all of the requirements of the above listed documents.

1.2 SCOPE OF WORK

1. This section provides for the complete installation of bus feeders and bus risers to IEC 61439 -1 & 2, as detailed on the drawings and as specified hereinafter.

    Current ratings identified on drawings are for onsite requirements. Equipment provided shall be de-rated accordingly to take into account voltage drop, and ambient temperature of 50 Deg. C. The Contractor shall submit a manufacturer's confirmation to this effect or suitable de-rating calculations/curves for the Engineer's review.

2. Bus Risers
    1. From the designated main low voltage switchboards, supply and install Aluminum / copper bus risers through the building as detailed.
    2. The bus risers in the basement, Mechanical rooms and roof shall be weather proof totally enclosed feeder type to IP65 and shall be installed at high level through the basement service tunnel up to final destination (chillers, generators).
    3. At the tower riser locations change the bus from weatherproof totally enclosed feeder type to plug in type IP43.
    4. The bus riser shall be installed vertically up through the building to allow for tap off disconnect switches to be mounted directly to the tap off bus.
    5. Provide internal and external fire barriers as required at floor penetrations in vertical runs and at penetrations through fire-rated walls on horizontal as required to maintain the fire rating of the surrounding area.
    6. Bases on manufacture's recommendations provide expansion joints to allow for expansion and contraction of the Aluminum / copper bars. This applies to both horizontal and vertical runs.
    7. Provide flanges at all wall and floor penetrations in finished areas.

8. Provide fire barriers as required to maintain the fire rating of the adjacent areas where the bus riser passes through fire rated walls, floors and openings in both horizontal and vertical runs.

1.3 QUALITY ASSURANCE

1. Acceptable Manufacturers

    1. Subject to compliance with the requirements of the Contract Documents, acceptable manufacturers are to be firms regularly engaged in manufacture of all materials specified in this section of types and sizes required, whose products have been in satisfactory use under similar service conditions for not less than fifteen years or as approved by consultant.

1.4 SUBMITTALS

1. Reference Applicable Divisions - Submittals.

2. Reference Applicable Divisions - Shop Drawings, Product Data and Samples.

3. Shop Drawings

    Submit shop drawings of:

    1. Detailed, dimensioned routing drawings of all bus ducts throughout the building, indicating the relationship to all structural slabs & Walls. Detail all points and methods of support. Detail all tap offs. Detail dimensioned data of each section of duct run. Provide voltage drop tests of each type of bus duct.

    2. Weather proof totally enclosed feeder type bus duct including details of all bends, angles, supports, etc.

    3. Plug in type bus duct including details of all bends, angles, supports, tap offs etc.

PART 2 EXECUTION

2.1 INSTALLATION

1. Ensure that final installation of busway assembly is fully co-ordinated with aspects of building construction and with the work of other trades. Final field measurements shall be made by the contractor prior to the release of the bus duct for fabrication.

2. Install busways and associated fittings, supports, spring hangers for vertical runs and accessories as indicated in accordance with manufacturer's recommendations. Manufacturer's authorized engineer professional shall supervise and certify the busduct installations.

3. Space hangers in accordance with manufacturers recommendations. But maximum spacing of 2m for both horizontal and vertical runs of busways. Vertical runs shall be supported by spring hangers.

4. Tighten busway joint bolts to loading recommended by busway manufacturer.

5. Cover busways with plastic envelope until building is clean and bus ready for Insulation resistance testing and energized.

6. Perform the Insulation Resistance Test of bus ways in presence of Engineer and get the approval on the observed readings.

7. Re-torque single bolt sandwich type busway as recommended by manufacturer.

2.2 TESTING INSPECTION AND COMMISSIONING

The tests to be carried out in accordance to International Standards and in presence Engineer and owner at factory. Test report shall be provided and shall include but not necessarily be limited to:

1. Submit factory type test certificates.

2. Inspect physical and mechanical condition.

3. Inspect anchorage, alignment and grounding.

4. Prior to system commissioning, perform all Electrical tests including:
   - Insulation Resistance Test
   - Dielectric Voltage Withstand Test
   - Contact Resistance Test

   Comprehensive report should be submitted in soft copy format as well as paper form.

   These tests shall be witnessed and certified by the Engineer in the presence of installer / manufacturer.

5. Load banks along with cabling and necessary accessories for connection with bus bars to reach 80% of the rating of bus bars shall be provided by the Contractor.

END OF SECTION

Section-14: Switches & Outlets

1.0 LOCAL SWITCHES

1.1 The local switches shall be 10/20 amp. Gang type , one-way, two-way, intermediate or double pole as indicated on the drawings. Where more than one switch is indicated at any position multiple gang units shall be used.

1.2 Switches shall be of the quick start make, slow break type specially designed for AC circuits to BS Standards. The operation of the switch shall not depend wholly on the action of the spring. The switches shall generally be of the rocker operated type.

1.3 All switch boxes shall be supplied with adjustable steel grids and earthing terminals.

1.4 Generally, switch units shall be of the adjustable grid pattern and to be secured to the adjustable grid by means of screws. For flush mounting switches the switch-plate shall overlap all edges of the box by not less than 7mm. For surface mounting switches the switch plate shall finish flush with the edges of the switch boxes. Switches for water heaters and fan coil units shall be complete with neon indicator lights.

1.5 In Plant rooms the switch units shall be surface or flush as required.

1.6 Local switches shall be arranged in convenient positions for switching the various circuits and generally as indicated on the drawings.

1.7 The switches shall be of the same manufacture for a particular type of switch throughout the installation. All accessories in wet and damp areas shall be of the splash-proof type to IP54 protection standard.

1.8 All switch boxes should be galvanized steel.

1.9 To ensure easy and correct connection of the conductors during installation, the necessary terminal shall be easily identified, grouped in line, upward facing, captive and backed out prior to the installation.

1.10 All dimmer switches shall be suitably rated to the lighting load being Controlled with 25% spare capacity and shall be adequate for tungsten and / or fluorescent lighting as specified.

2.0 POWER OUTLETS

2.1 The switch socket outlets, shall be in accordance with BS1363 Standard as appropriate and shall be of the three pin grounding type.

2.2 Switch socket outlet in the different areas shall comply with section 607 of BS7671 :2001

2.3 Live contact of the socket shall be completely shuttered such that it is not possible to engage any pin of the plug into a live contact whilst any other pin of the plug is exposed.

2.4 All floor mounted socket outlets shall be fixed as part of the under floor trunking service boxes.

2.5 These outlets shall be of the same manufacturer throughout the installation.

2.6 The sockets should provide a double earth terminal as per latest BS7671, 2001, Section 607.

3.0 FUSE CONNECTION UNITS / DP SWITCHES

3.1 These shall be of flush or surface mounting type as manufactured in compliance with BS Standard as appropriate. The fuse connection units shall incorporate integral switch, neon indicator and 20 amp fuse links. The DP switches supplied for water heaters shall be incorporated with neon indicator lights, and these also shall be engraved 'Water Heater'.

3.2 These shall be of the same manufacturer for a particular type of switch throughout the installation and shall be complete with the other accessories installed.

3.3 Fuse selection shall be based on actual requirement of equipments.

4.0 GI BOXES

GI boxes to be provided with brass earth terminal to facilitate earth wire connection. The boxes to have sufficient number of 20mm and 25mm knockout. The boxes thickness shall be 1.1mm minimum and shall comply with BS 4662. Boxes to have adjustable lug for proper installations of wiring accessories. Extension ring to be used along with GI boxes, in places where the box is deep inside the wall, marble or concrete.

5.0 ISOLATORS

All external isolators must have IP-65 protection with aluminum alloy or die-cast aluminium housing with bolt on drip proof canopy. Isolators must be de-rated for 50 deg. Ambient temperature. Internal isolators shall be IP 54 / IP 65 depending on the location with polycarbonate housing for non-armoured cables.

6.0 FLOOR SERVICE BOXES

Floor Service Boxes shall be two-compartment type of the size 300 x 300 x 75-90mm and shall be constructed from high-pressure Zinc Alloy die casting base frame pillars. This shall be fixed on to heavy gauge galvanized steel base plate for support by support frame. Other materials adequate in strength and performance shall be used and these shall be protected against corrosion. The boxes shall be constructed with provisions for ducting or conduit access on all four sides. Unwanted entries shall be blanked off with detachable side blanks.

Cover for floor service boxes shall be made of high pressure zinc alloy die casting provided with suitable hinges designed to enable the trap cover to open through 180 degrees and giving access at all times to the power and telephone outlets.

Covers for junction boxes shall be made of high pressure Zinc Alloy die casting with 12mm recess to receive ceramic tiles or carpet tiles. Counter sunk screws shall secure the covers of boxes. All exposed portions of the boxes shall be epoxy coated in grey color.

All boxes shall have extra wide gaskets in order to minimize water seepage. Gaskets shall be made of material that is durable in order to withstand loads.

All boxes shall be adjustable in height independently of the ducting system to take account of difference in floor thickness.

Adequate segregation shall be provided between service runs within boxes by using cross-over bridges and rigid compartments.

Circuit protective conductors shall be provided between the covers and the boxes.

Cable emerging for service boxes shall be protected against damage by means of nylon cables exit grommets or equivalent and shall be reversible to close position when not in use.

7.0 ACCESSORIES PLATE FINISH

7.1 All the wiring accessories shall be vandal proof. The accessories plate shall have the following finishes depending on the location where it is installed and on the feeding arrangement.

Switches to comply with BS 3676:2000, and sockets to BS 1363, ceiling rose to BS67 : 1999.

a) All external outlets and outlets in pump room and parking shall be weatherproof to IP-66.

b) Weatherproof range should be suitable for semi recessed mounting and supplied with back boxes.

c) All outlets above false ceiling, store, etc. shall be white plastic.

d) Switches and outlets in apartments shall be white plastic slim type.

e) Main entrance, common area and lift lobbies shall be matt chrome steel face plate slim type.

f) Outlets in Electrical rooms, Mechanical floors, Tel. Rooms, etc shall be metal clad.

g) All switch plates including SSOs are to be coordinated with tiling layouts by prior agreement with the Architect on site.

8.0 MOUNTING HEIGHTS

The mounting heights for the electrical equipment and accessories shall be coordinated with the furniture layout and shall be as per site requirements to Engineer's / ID's instruction and approval. In general the mounting heights from FFL to center of fixtures shall be as shown in legend.

END OF SECTION

Section-15: Diesel Gensets

1.1 SCOPE OF WORK

The work under this Section consists of the following.

a. Supply, installation, testing and commissioning and transportation of Diesel Generator set, relevant material and all the allied accessories as specified herein or as given and in the Bill of Quantities.

b. The generators are Prime rating, shall be placed as located in drawing on a 6" raised RCC pad or as required by generator supplier.

c. The contractor shall discuss the electrical layout with the Consultant and coordinate at site with other services for the exact route, location and position of control/power cable and equipment.

The supplier shall prepare the complete shop Drawings based upon the installation manual of manufacturer and Bill of Quantities for showing the installation layout along with material / accessories to be used for the following.

a) Installation, mounting and fixing details of the generators on the foundation pad

b) Fabrication and Installation of Diesel Tank

c) Fabrication and Installation of Cable Trays (where ever required)

d) The Contractors shall perform test of leakage.

e) The Installation contractor shall provide all coordination & supports to the Supplier fo the commissioning of the Generators. (In case, of third party contractor)

f) Fabrication and installation details / layout for lube oil Tanks.

g) Fabrication and Installation details / layout for Diesel Day Tank.

h) Shop drawings for relevant pipes of Flue Gas system.

1.2 TECHNICAL SPECIFICATIONS

1.2.1 General Performance Requirements

1.2.1.1 The generating sets shall be of standard design of reputed manufacturer as described in approved manufacturer list and other control to be of the generator manufacturer's, who shall have similar units in operations under similar applications & field conditions. The generator set shall comply with IEC 60034-1.

1.2.1.2 The generator set shall be specially designed for low ambient noise level, suitable for indoor use with a maximum noise level (dB) as mentioned in the summarized specifications attached here with. The bidder shall state with his bid the value of noise during operation.

1.2.1.3 Each generating set shall after reducing the power absorbed by the auxiliaries deliver continuous specified power output at 400 volts and 0.8 power factor, 3-phase, 50 Hz under full load condition, should have capability of voltage variation from 380-440V.

All auxiliaries, accessories and connection systems along-with all necessary cables, fittings, hardware etc. for complete vibration proof installation of prime-mover, generator, control panel including starting, inlet, exhaust, cooling system, etc. are to be included in the scope of supply.

1.2.1.4 The engine shall be directly coupled to the generator with a maximum r.p.m speed as shown in summarized specifications attached here with.

1.2.1.5 The engine-generator package shall be mounted on vibration proof spring / rubber pads. Heavy duty lifting eyes and jacking screws shall be provided on the skids. Supplier shall provide foundation design and shall supply foundation bolts and any other material / hardware for complete installation of the package. Any excessive torsional vibration shall be avoided for both engine and alternator.

1.2.2 Specifications for Diesel Fuel Engine Prime Mover

1.2.2.1 Engine shall be four strokes, compression ignition engine (preferably electronic ignition).

1.2.2.2 Starting shall be done by the electric starter motor operated form 24V D.C lead acid batteries mounted on the skid. Batteries shall be provided by the supplier. The engine shall be equipped with an alternator type automatic charging system to charge the batteries during normal engine operation. The charger and batteries shall be adequate to satisfy the following requirements.

a. Crank the engine at firing speed for at least 15 second.

b. Crank the engine three times for the above duration.

c. Fully charged the discharged batteries within eight hours.

1.2.2.3 Overload Capabilities

Engine shall be of continuous rating with overload capability of at least 10% above the normal rating for up-to 1 hour continuously in any 12 hour period. The rating of gen-set shall be in accordance to ISO 8528 and overload capability shall be in accordance to the ISO 3046.

1.2.2.4 Air Intake

Air intake shall be naturally aspirated, equipped with suitable filter.

1.2.2.5 Engine Cooling

Engine shall be fan cooled, water radiator type supplied with guard. Cooling system shall have an engine centrifugal pump for cooling water circulation.

1.2.2.6 Exhaust System

Exhaust system shall be equipped with double residential type silencer complete with muffler exhaust manifold, flexible connector, exhaust elbow, rain cap, and associated fittings. The exhaust line shall be taken outside the building in the shortest possible way and not to include too many bends. The exhaust line should be insulated along its way from the engine to the termination point at the wall.

At the termination, protection shall be provided form rain, etc. All the piping should be insulated with the glass wool wrap and then steel jacket.

1.2.2.7 Speed Governor

Electronic governor (to be mentioned clearly along with the bids) shall regulate engine speed so as to maintain the generator frequency within + 2 % of the specified output frequency. Stable engine speed shall be restored within 10 second after the engine has been started shall be restored within 8 second of any sudden load change from no load to full load. During the change of load surging period, the speed shall not vary by more than rated speed.

1.2.2.8 Instruments

Skid mounted panel shall have calibrated gauge / meters to measure the following

Engine speed.
Lube oil pressure.
Engine oil temperature.
Engine water temperature.
Engine running hours.
Diesel level meter / indicator (For Diesel Generator)
Pressure Gauge meter
Battery charging current.

1.2.3 Fuel System

For Diesel Engine:
Engine shall be operated on commercial high speed diesel oil. A fuel oil strainer / filter shall be provided in the fuel line.

Contractor shall also include complete fuel storage and transfer system. The tank shall have level gauge and pump to facilitate the pumping of diesel from drums / reservoir.

Contractor shall submit with the bid, details of fuel system and estimated fuel consumption at half, three quarter and full load operation. It shall have a vernier throttle control for speed adjustments.

1.2.4 Specification for Generator

1.2.4.1 Type generator shall be synchronous.

1.2.4.2 Excitation.

Excitation shall be brush less rotating diodes for 3-phase full wave rectification on mounted on the main shaft.

1.2.4.3 Windings

Alternator winding shall have class-H insulation with anti condensate heater for winding and shall be impregnated for tropical use.

1.2.4.4 Voltage Regulation

Voltage Regulator shall be solid state with provision for manual setting. Regulator shall be so designed as to protect the exciter when the generator is running at reduced speed during starting or idling of the Prime-mover. Voltage regulation shall be ±1% from no-load to full load.

1.2.4.5 Over Load Capability

The generator shall be capable of carrying 1 hour overload of 10% of nominal rated current with field set for normal rated load excitation for any 12 hour period. The rating of gen-set shall be in accordance to ISO 8528 and overload capability shall be in accordance to the ISO 3046.

1.2.4.6 Short Circuit Protection

Generator shall be capable of withstanding a minimum time as specified in IEC 60034-1, without injury for a three phase short circuit at its terminal when operating at rated kVA and power factor.

1.2.4.7 Over Speed

Synchronous generator shall be so constructed that in case of emergency they will withstand an over speed of 25% without mechanical injury.

1.2.4.8 Deviation Factor

The deviation factor of the open-circuit line to line terminal voltage shall not exceed 0.1.

1.2.4.9 Specifications for Control Penal

Control panel shall be skid mounted front access part of the engine-generator package. Removable bolt-on glands shall be provision to suit bottom entry. Panel shall be complete with all control wiring, pressure clamped terminal and lugs. Control panel shall be wired by flexible PVC insulated cable. All cables shall be suitable color coded and numbered for circuit identifications. Contractor shall submit with the bill all electrical and mechanical details and installation drawings. Panel shall be provided with connection for remote shut off operation.

1.2.5 Unit Control Section

This shall incorporate measuring instruments, instrument transformers, circuit breakers, voltage regulator, governor, voltage adjusting rheostat, battery charger, enunciators, indicating lamps etc.

1.2.5.1 Instruments

Following measuring instruments shall be provided.

a. Ammeter with selector switch.
b. Voltmeter with selector switch.
c. Frequency meter (dial type).
d. Kilowatt hour meter.
e. Ammeter (charging current).

1.2.5.2 Safety Devices

Following alarm/shutdown enunciators and safety device shall be provided.

a. Alarm and shutdown for.
-- High crank case low oil level.

b. Alarm and lockout.
-- Over crank.

c. Alarm and shutdown
-- Engine Over speed.

d. Alarm for battery charging

e. Winding temperature light alarm and shut down.

After shut down this set shall lock out and it shall not be possible to restart unless the fault has been removed and manually reset.

1.2.5.3 Circuit Breaker

All circuit breaker shall be triple-pole electromagnetic type with over-current under voltage, and short circuit protections.

1.2.5.4 Battery Charger

Battery charger shall be static type and shall supply a float charge to the batteries when the engine is not in operation. Work also includes the wiring from DB (LESCO) to charger.

1.3 TOOLS

A complete set of tools for routine operating and maintenance of engine and generator shall be furnished without additional cost. A detailed and comprehensive list of tools is to be provided by supplier along with the technical and commercial bid.

1.4 TECHNICAL DATA

Details to be provided with this quotation.

1.5 ENERGY METER / HOUR METER

An energy meter of suitable rating and to meet the requirement of electrical inspector to record the total operating hours of the generator an HOUR-OPERATION-METER shall also be provided.

1.6 VIBRATION ISOLATORS:

The generators should be securely fixed & mounted on rubber pad foundation to avoid transfer of vibrations to earth, foundation of building, walls etc.

1.7 FACTORY ASSESSMENT TEST:

Pre-delivery factory assessment test shall be performed in the presence of Consultant's representative. Refer annexure B for complete list of tests to be performed.

1.8 SPECIAL INSTRUCTIONS FOR THE BIDDERS

The supplier shall prepare the complete shop Drawings based upon the installation manual of manufacturer and Bill of Quantities for showing the installation layout along with material / accessories to be used for the following.

Section-16: Uninterruptable Power Supply

PART 1 - GENERAL

1.1 SUMMARY

A. This specification describes the three-phase or single-phase or as specified, on-line, double conversion pure sine wave, continuous operation, solid-state uninterruptible power supply (UPS). The UPS shall operate as an active power control system, working in conjunction with the building electrical system to provide power conditioning and on-line power protection for the critical loads.

1.2 STANDARDS

A. **Safety:** EN/ IEC 62040-1
B. EMC/IEC 62040-2 (Class C2 and C3)
C. **Performance**: EN/IEC 62040

1.3 QUALITY ASSURANCE

A. **Manufacturer Qualifications:** Manufacturer shall be a firm engaged in the manufacture of solid state UPS of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of 20 years.

a. The manufacturer shall be ISO 9001 & 14001 certified and shall be designed to internationally accepted standards.

1.4 WARRANTY

A. The manufacturer's standard warranty shall in no event be for a period of less than 24 months starting from beneficial use of the equipment. Submittals received without written warranties as specified will be rejected in their entirety. Maintenance during reliability period shall also be covered in the warranty section.

1.5 CLASSIFICATION

A. Classification according to EN/IEC 62040-3

1.6 SUBMITTALS

A. **Product data:** Submit product data showing material proposed. Submit sufficient information to determine compliance with the Drawings and Specifications.

1. Bill of materials for the proposed system
2. Product catalogue sheets or equipment brochures
3. Product guide specifications
4. System single-line operation diagram
5. Floor layout / Footprints
6. Installation guide
7. Drawings for requested optional accessories

B. Operation and Maintenance Data:

Submit operation and maintenance data to include in operation and maintenance manuals but not limited to, safe and correct operation of UPS functions.

1. Submit an installation manual, which shall include, but shall not be limited to, instructions for storage, handling, examination, preparation, installation, and start-up of all systems.

2. Submit an operation and maintenance manual, which shall include, but shall not be limited to, operating instructions.

3. Submit equipment drawings, dimensions and schematics.

1.7 PROJECT CONDITIONS

A. **Environmental Requirements:** Do not install solid state UPS until space is enclosed and weather proof, wet work in space is completed and nominally dry, work above ceilings is complete, and ambient temperature and humidity conditions are and will be continuously maintained at values near those indicated for final occupancy.

1. The UPS shall be capable of withstanding any combination of the following environmental conditions in which it must operate without mechanical or electrical damage, or degradation of operating characteristics.

   a. **Storage Ambient Temperature:** -15°C to 40°C with batteries; -30°C to 70°C without batteries

   b. **Operating Ambient Temperature: -**10°C to 40°C.

   c. **Relative humidity:** 0 to 95%, non-condensing.

   d. **Storage elevation:** 0 to 20000 m.

   e. **Altitude:** Maximum installation with no de-rating of the UPS above sea level shall be:

      1) 2800 m: 100% load
      2) 3300 m: 95% load
      3) 3800 m: 91% load
      4) 4300 m: 86% load
      5) 4800 m: 82% load

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. **Basis of Design:** Items specified are to establish a standard of quality for design, function, materials, and appearance. Only the products from the approved manufacturers are acceptable.
The Architect/Engineer will be the sole judge of the basis of what is equivalent. Examples of modifications include, but are not limited to the following:

1. Structural reinforcement to accommodate heavier equipment.

2. Increased sizes of circuit breakers, raceways and wiring.

3. Larger back-up generators (including upgraded accessories and wiring) to avoid instability caused by most double conversion UPS systems.

4. Larger HVAC equipment (including duct work and wiring) to accommodate increased heat dissipation of less efficient UPS systems.

5. Filters to prevent input distortion, avoid upstream equipment malfunction and failure of power factor equipment.

2.2 DESCRIPTION

A. The UPS shall consist of the following easy to repair modular rectifier/inverter sections and easy to install internal and external modular battery units.

B. The UPS shall be provided with separate feeds for rectifier/inverter section and the static bypass switch.

C. Modes of operation: The UPS shall operate as an on-line system in the following modes:

1. **Normal:** The inverter and the rectifier shall operate in an on-line manner to continuously regulate the power to the critical load. The rectifier shall derive power from the AC input source and supply DC power to float charge the battery.

2. **Battery:** Upon failure of the AC input source, the critical load shall continue being supplied by the inverter without any switching. The inverter shall obtain its power from the battery. There shall be no interruption in power to the critical load upon failure or restoration of the AC input source.

3. **Recharge:** Upon restoration of the AC input source, the UPS shall simultaneously recharge the battery and regulate the power to the critical load.

4. **Static Bypass:** The static bypass switch shall be used for transferring the critical load to input supply without interruption. Automatic re-transfer to normal operation shall also be accomplished with no interruption in power to the critical load. The static bypass switch shall be fully rated and shall be capable of manual operation. The UPS shall be able to recharge the batteries while supplying full power to the load via the static bypass switch.

5. **Internal maintenance bypass:** The UPS shall be provided with an internal manual bypass to simplify the installation and shall be used for supplying the load directly from the mains supply, while the UPS is taken out for maintenance.

2.3 STATIC UPS

A. **General:** The UPS shall be housed in a freestanding enclosure. The enclosure shall be designed to blend into an IT environment. The cabinet shall be equipped for fork truck lifting. The UPS cabinet shall be painted with the manufacturer's standard color. All service access shall be from the front. Installation access shall be from the lower backside of the system.

1. The UPS shall be in a self contained cabinet and comprise **30 kVA** and **6 kVA** power section; Bypass Static Switch; Battery for standard run time and interface LCD display all mounted in a separate cabinet. The UPS shall permit user installable and removable battery units.

   The power section shall be of the Double Conversion On-Line topology with power factor corrected inputs.

   a. The UPS battery shall be sized for desired kVA Ratings at a power factor of 0.9 for 10 minutes (minimum).

2. The UPS shall have a short circuit withstand capability of 30 kA.

2.4 COMPONENT DESCRIPTION

A. **Rectifier**

1. Each UPS power module shall include an active power factor corrected, Insulated Gated Bipolar Transistor (IGBT) rectifier.

2. The input current limiter must be design to support 100% load, charge batteries at 10% of the UPS output rating, and provide regulation with mains deviation of up/down to+/-15% of the nominal input voltage. During an overload condition the input current must be limited to maximum 125% of the nominal output current.

3. The battery charging shall keep the DC bus float voltage of +/- 219 V, +/-1%

4. DC ripple voltage shall be less than ±1% of nominal with no battery connected.

5. Input power factor shall be 0.9(min.) lagging at 100% load without the use of passive filters.

6. Rectifier shall employ electronic waveform control technology to maintain the current sinusoidal.

7. Pulse Width Modulation (PWM) current control shall be used. Digital Signal Processors (DSP) shall be used for all monitoring and control tasks. Analog control is not acceptable.

8. Reflected input current Total Harmonic Distortion (THD) shall not exceed 5% at 100% load.

9. Typical battery re-charge time as per IEEE 485.

B. **Batteries**

1. Standard battery technology shall be Dry Sealed Maintenance Free

2. Batteries shall be housed in the same rack as the power section or in a separate enclosure. Batteries shall be modular on pull out shelves for quick replacement and servicing.

3. Battery voltage shall be Battery Temperature Compensated as outlined in the rectifier section above.

4. **End of discharge:** 150VDC.

5. For longer runtimes, external battery frames in the same design may be offered.

6. **Battery Charge Current Limit:** The UPS shall be capable of limiting the energy sourced from the mains for purposes of battery charging. As a default setting, the battery charge energy will be set to 100% of its nominal value. When signaled by a dry contact, (such as from an emergency generator) the UPS shall be capable of limiting the battery charge energy taken from the mains. This shall take place in user selectable increments of 75%, 50%, 25%, 10% and 0% of the nominal charge power. The selection shall be made from the UPS front panel display/control unit.

7. The battery charging circuit shall remain active when in Static Bypass and in Normal Operation.

8. The batteries charger shall allow cyclic charging when system is running in normal operation and batteries are full charged to extend the battery life. This operation shall be selectable in the display. Cyclic charge should be 10 hours on and 48 hours off. The Cyclic charge shall end if UPS is overloaded, switch to battery operation, battery voltage drops below 200 V or are deactivated by user.

9. The UPS battery shall be of modular construction made up of user replaceable, hot swappable, fused, battery modules. Each battery module shall be monitored to determine the highest battery unit temperature for use by the UPS battery diagnostic, and temperature compensated charger circuitry.

10. The battery blocks housed within each removable battery module shall be of the Dry Sealed Maintenance Free type.

C. Inverter

1. The inverter shall consist of fast switching IGBT power module.

2. Inverter shall be PWM controlled using DSP logic. Analog control shall not be acceptable.

3. The inverter modules shall be rated for an output power factor at 0.8.

4. Nominal output voltage shall be 1×230 V and adjustable for 1×220 V or 1×240 V, 50 Hz, L1,N,PE.

5. **Efficiency of each module at full load:** Not less than 92% (minimum)

6. **Output Voltage Total Harmonic Distortion at full load:**

   a. Less than 1.5% for 100% resistive load.
   b. Less than 3.5% for computer load as defined by EN50091-3/IEC 62040-3.

7. **Output voltage regulation:**

   a. **Static:** Less than 1% at full linear load.
   b. **Dynamic:** 5% at 100% step load.

8. **Output frequency:** 50 Hz free running.

9. **Crest factor:** Unlimited but regulates it down to 2.7.

   a. Remote Emergency Power Off (EPO) shall be standard (wall switch and wiring shall be provided by the electrical contractor).

D. Static Bypass Switch

1. The static switch shall consist of fully rated Silicon Controlled Rectifiers (SCRs). Part rated SCRs with a wrap around contactor are not acceptable.

2. **The static bypass switch shall automatically transfer the critical load to bypass input supply without interruption after the logic senses one of the following conditions:**

   a. Inverter overload beyond rating.
   b. Battery runtime expired and bypass available.
   c. Inverter failure.
   d. Fatal error in control system.

3. The static bypass switch shall automatically retransfer from bypass to the inverter, when one of the following conditions occurs:

   a. After an instantaneous overload-induced transfer has occurred and the load current has returned to less than 100% of the system rating.

   b. The inverter is active (on).

4. The static bypass switch shall be equipped with a manual means of transferring the load to bypass and back to inverter.

5. If more than 10 transfers from and to inverter occur in a 1 minutes period, the load shall be locked on static bypass. An alarm communicating this condition shall be annunciated.

E. **Mechanical**

1. The ups power section, static bypass switch, internal manual bypass switch and the dry sealed maintenance free batteries (for standard runtimes) shall be housed in a freestanding enclosure. The enclosure shall be designed to blend into an IT environment. The UPS cabinet shall be painted with the manufacturer's standard color. All service access shall be from the front. The enclosure shall have the following specifications:

a. Heavy-duty design with an all-metal construction.
b. Caster fitted for mobility. Leveling feet shall be supplied as standard.
c. Electrostatic applied paint.
d. The cable entry shall be from the bottom on the back of the UPS.
e. The UPS enclosure shall meet an ingress level of min. IP52
f. The UPS should be fitted with dust filter in the air inlet to filter dust, molds and spores with particles larger than 3 m.

2.5 SYSTEM CONTROLS AND INDICATORS

A. **General:** A microprocessor controlled display unit shall be located on the front of the system. The display shall consist of an alphanumeric display with backlight, an alarm LED, and a keypad consisting of pushbutton switches.

1. **The following metered data, shall be available on the alphanumeric display but shall not limited to:**

   a. Time record of occurring events.
   b. Input AC Voltage
   c. Output AC voltage
   d. Output AC current
   e. Input Frequency
   f. Battery voltage
   g. Highest Internal Battery temperature

2. The display unit shall allow the user to display an event log of all active alarms and of the 50 most recent status and alarm events (minimum).

3. **For purposes of remote communications with the UPS the following shall be available and contained within the UPS on a removable, "hot swappable" "smart slot" interface card:**
   a) RJ-45 Interface port for remote communications with a network via web browser or SNMP.

   b) Environmental monitoring feature, capable of locally monitoring temperature and humidity as well as two additional generic set of user determined dry contacts capable of taking an input signal from any third party on/off signal, such as water detection, smoke detection, motion, or fire detection.

2.6 ACCESSORIES

A. **Extended runtime (XR) option**

1. For purposes of extending the UPS battery runtime, external extended runtime options shall be available. The extended runtime option shall be housed in "line up and match" type enclosures and shall contain necessary hardware and cables to connect to the UPS, or between enclosures. Each XR enclosure shall be equipped with removable, hot swappable, battery units housed in draw-out cartridges.

2. The extended runtime system shall have a 250 V DC rated, thermal magnetic trip molded case circuit breaker. Each circuit breaker shall be equipped with shunt trip mechanisms and 1A/1B auxiliary contacts. The circuit breakers are to be equipped as part of a line-up-and match type battery enclosure.

B. **Software and connectivity**

1. The Ethernet Web/SNMP Adaptor shall allow one or more network management systems (NMS) to monitor and manage the UPS in TCP/IP network environments. The management information base (MIB) shall be provided in DOS and UNIX formats. The SNMP interface

adaptor shall be connected to the UPS via the RS232 serial port on the standard communication interface board.

2. The UPS, in conjunction with a network interface card, shall be capable of gracefully shutting down one or more operating systems during when the UPS is on reserve mode.

3. The UPS shall also be capable of using an RS232 port to communicate by means of serial communications to gracefully shut down one or more operating systems during an on battery situation.

C. **Remote UPS monitoring:** The following three methods of remote UPS monitoring shall be available:

1. **Web Monitoring:** Remote monitoring shall be available via a web browser such as Internet Explorer.

2. **RS232 Monitoring:** Remote UPS monitoring shall be possible via either RS232 or contact closure signals from the UPS.

3. **Simple Network Management Protocol (SNMP):** Remote UPS Monitoring shall be possible through a standard MIB II compliant platform.

D. **Software compatibility:** The UPS manufacturer shall have available software to support graceful shutdown and or remote monitoring for the maximum prevailing operating systems.

END OF SECTION

Section-17: Lighting

1.0 GENERAL

All lighting fixtures complete detailes, including: wattage, luminous flux, energy label class, average lamp life, switching cycles, colour temperature, length and diameter, location of production, compliance with relevant standards and complete with lamps, accessories, installation materials, etc. shall be furnished and installed as per drawings. The fixtures shall be designed and built to give reliable service continuously at the normal voltage and current rating.

The light fitting schedule is given on the drawing and each type is specified in detail in the Bill of Quantities. The manufacturer's type and catalog number specified shall serve as illustration of the type of fixture required and any other approved equivalent fitting shall be acceptable. The equivalency shall be based on certified photometric data, as well as on construction material, shape, finish, etc. The Contractor shall submit complete technical details and/or samples of each and every lighting fixture specified and obtain approval of the Consultant before commencing with placement of order.

2.0 FLUORESCENT LIGHT FIXTURES.

2.1 All the light fixtures shall have lamps and efficient ballasts of the wattage specified. The fluorescent lamp color shall generally be day light, cool day light and/or warm white in the order of preference or as mentioned specifically. The fluorescent lamps shall be in accordance to List of Approved Manufacturer but having a minimum useful life of 5000 hours.

2.2 The ballast shall be totally enclosed efficient type suitable for operation on 220 V, 50 Hz, single phase supply, a wiring diagram, wattage, voltage and current ratings shall be printed on the body of the ballast. The power loss shall not be more than 10 watts for 40 watts ballast. The ballast shall be noiseless in operation without any whistling sound. The measurement shall be called upon to guarantee a trouble-free life of 3 years, effective from the date of completion Certificate.

2.3 All light fixtures shall be provided with power factor improvement capacitors. The following capacitor combinations shall be used / wired on 'du' circuits. For 2x40 watts fixture 3.7 mfd capacitor 380 volts. For 2x40 watts fixture 3.7 mfd capacitor 400 volts.

2.4 The lamp holder shall be lock-in rotary type.

2.5 The starters shall have radio-interference suppressers.

2.6 The internal wiring of the light fixture shall be carried out at manufacturers factory with heat resistance wires of size not less than 1.5mm square.

2.7 The louvers of light fixtures shall be made of anodized aluminum and/or non yellowing white painted steel louvers.

2.8 The body of the light fixture shall be white or grey stove enamel as required. The industrial reflector shall have white stove enamel finish inside and gray/green stove enamel finish outside. Appropriate sized bushed entry holes, and fixing holes shall be provided. The thickness of the sheet steel used in the fabrication of the body and reflector shall not be less than 22 gauge.

2.9 Pendent type of fixture shall have 2 Nos. 1/2" dia. chromium plated pendent tubes for suspension or as per detail shown on drawings.

3 LED LIGHT FIXTURES.

3.1 All the LED light fixtures shall have efficient driver circuitry suitable for 230V, + 10% for AC supply, conversation efficiency more than 92% along with No speckle, no flickering, no humming, no buzzing, no RF interference. The luminaire suitable for input voltage range from 85 VAC- 265 VAC and power factor => 0.9, suitable for at 50 Hz frequency as per utility power characteristics.

3.2 All aspects of the lighting system shall be appropriate, consistent and suitable for the specific environment or work task required, and where appropriate, a mixture of light fittings, including down lighters, wall washers and uplighters shall be provided.

3.3 Luminaires shall have an efficacy of NOT less than 80lm/W with THD less than 20%.

3.4 The housing for of light must have feasible material for maximum heat dissipation to insure the maximum life of the luminaire along with frosted non-brittle, non-decoloring cover with minimum 5 years of life span as per recommendation of engineer-in-charge.

2.5 The luminaire should have CRI Index greater than 75 along with the color temperature range as specified by engineer in-charge available from 3000 K to 6500 K having IP Rating 20-40 (for indoor use) and IP-65 or greater for outdoor use.

2.6 The manufacturer should provide third party test reports from reputable laboratory (Local - PCSIR/ CERAD UET /Equivalent) or international firm along with all the photometric data specification as per CIBSE/IEC, CE, RoHS relevant standards.

2.7 The manufacturer should provide lifetime warranty 30,000 Hours or more (per LED Chip LM-80 report), three-year service warranty to engineer in-charge.

4 ROAD LIGHTING.

Pole mounted (8-10 meters high) or duly approved by the engineer LED luminaires shall be used for open area lighting. The fixture shall have a die cast/ Extruded aluminum housing providing adequate rigidity, strength and heat dissipation. The housing shall have integrated driver and Led compartments for better heat dissipation and both LED module & driver compartment must separate for convenience in maintenance at the site and to avoid Driver and LED Compartments thermal effect to each other. The optical LED component shall have thermally hardened glass cover and high-quality silicon gaskets. The glass shall be extra white for maximum light transmission. The glass cover shall be lightly secured with the housing. The housing shall feature highly reflective components and films to increase light output. The light output ratio (LOR) shall not be less than 85% The luminaries shall offer a composite system efficacy of minimum 100 lumen/watt Ensure maximum spread of light by using any efficient technique, shall carry defined inner and outer profile for high efficiency LED to ensure maximum spacing between the road lighting poles and coverage of wider roads (according to center/ pole distance in meter and pole height). The multilayer optics design will be preferred for adequate luminance and luminance uniformity in the unlikely event of an individual LED failure. The optical (lens/ glass) system shall feature long life with no discoloration, highest possible light transmission and white painted circuit board for high reflectivity for maximum light output. Plastic/Acrylic should not pale within warranty time. The LED compartment of luminaire shall have ingress protection class IP66 for long reliable performance and minimal maintenance

requirements and impact resistance of IK08 or above. No chemical glue shall to be used as that may cause breakdown of water proof, dust proof and corrosion proof. The test reports shall be submitted by the manufacturer per relevant IEC/CIBSE/CERAD UET Recommendation & Standards. Luminaire and accessories warranty 3 years. Complete replacement of luminaire in case of manufacturing fault.

5 DIMMABLE LIGHT FIXTURES.

For areas where dimmer shall be provided the provision of fluorescent light fixtures in general and its allied control gear in particular shall be strictly in accordance with the manufacturer's recommendations and to the entire satisfaction of the Engineer.

The requirement of control circuiting depending upon the type of fluorescent tubes (rods) used 38mm dia. or 26mm dia. with or without metallic firing strip (or metal net) shall be strictly conforming to manufacturers recommendations. Wiring diagrams of each light fixture showing the relative position of ordinary and/or electronic ballasts, filament transformers, base load resistors and compensating p.f. capacitor shall be submitted to the Engineer for approval along with detailed specification of each component and with technical brochures.

6 DIMMERS.

The dimmers used shall be universal type i.e. suitable for use with incandescent and fluorescent lamps. The planning of making three phase assemblies and integration with relevant distribution boards specified hereinafter shall be contractor's responsibility. The dimmer rack assemblies shall be sheet steel clad, flush wall mounting type, modular in construction and solid-state design comprising of automatic and slave dimmers suitable for operation on 3 phase, 400 volts, 50Hz supply. Each dimmer rack assembly shall be provided with direct or remote, as most suitable to requirement, push button control plates with the following five standard options: -

Light dark-preset-stop-ON/OFF.

The capacity of the dimmer rack assembly shall be commensurate with the installed lighting load.

The schematic wiring diagram of the dimmers showing the relative position of its components e.g. Isolators, thyristors, contractors, RYB indicator, instruments, fuses, relays and MCB's for final sub-circuit protection and push button controls shall be submitted to the Engineer for approval.

he dimers shall be manufactured by M/s. Polaron Controls U.K., M/s. Strand Lighting U.K. and/or M/s. Altenburg Germany.

7 MEASUREMENT.

Actual number of units installed shall be taken as the basis for measurement or as specified in BOQ.

8.0 LIGHTING EQUIPMENT, GENERAL INSTALLATION REQUIREMENTS

8.1 Complete manufacturers data shall be supplied along with the proposal of luminaries.

8.2 Lighting equipment and lighting fixtures shall be as called for on plans by designated symbols and type. Said equipment shall embody the highest standards of electrical and mechanical design with maximum efficiency obtainable and all shall be subject to the approval of the Engineer.

8.3 All hangers, cables, supports, channels, frames and brackets of all kinds for safely erecting this equipment in place, shall be furnished from the standard manufacturer's product range and shall be erected in place under this Section.

8.4 Each lighting fixture shall have a manufacturer's label affixed to it and shall comply with the requirements of all authorities having jurisdiction.

8.5 The right to select other fixtures of the same quality, without additional cost to the Employer is reserved by the Engineer regarding the shape of the lighting luminaire.

8.6 The supply to lighting fittings mounted on or recessed into a false ceiling shall be effected by means of a ceiling rose on a conduit box within the false ceiling space with a three core heat resisting flexible cable connection. When fixtures are surface mounted to the ceiling. Ceiling rose to be provided adjacent to the fitting. In plasterboard ceiling areas, ceiling rose to be installed and supported next to the luminaire with a backbox to terminate the flexible conduit from the conduit box within slab at high level.

8.7 All prismatic controllers for fluorescent fittings shall be of the injection moulded acrylic type to obviate discoloration. Plastic diffusers will not be accepted.

9.0 EXTERNAL LIGHTING, GENERAL INSTALLATION REQUIREMENTS

9.1 Furnish and install external lighting fittings of the types specified and, in the positions, indicated on the drawings. Check all requirements regarding conduit runs and positions and the casting in of conduit.

9.2 The Contractor shall also be responsible for the installation and wiring of the external lighting installation as shown on the drawing and in accordance with the schedule of light fittings.

9.3 Each mounting bracket pole shall be fitted with a fuse unit of approved manufacturer connecting to the lighting units mounted on the bracket.

END OF SECTION

Section-18: Public Address System

1.0 GENERAL

The Contractor shall allow for the supply, installation, testing and commissioning of a Back-ground Music / Public Address system comprising of Amplifiers, loudspeakers and all necessary cabling and termination. The system shall be generally as indicated on the drawings and as herein specified, to the approval of the Engineer.

The complete system shall be supplied by a specialist Subcontractor having at least five years experience in the field. All equipment supplied shall be from one reputed manufacturer and shall be installed by the authorized representative of the manufacturer. All the equipment included in this system shall be covered by manufacturer's warranty for minimum five years.

For the purpose of Public Address System the speakers are grouped into different zones as follows;

a) Corridors and Passage
b) Toilets
c) Prayer Area
d) Parking

Different level of priorities as per following shall be allotted to different signals for transmission through same speaker.

a) Emergency announcements	Highest priority
b) Fire tone	Next
c) Music	Least

All control consoles shall be placed in the Control / Management Room. Announcement shall be played from the Control / Management Room.
The announcement shall be made in individual mode (i.e one zone at a time) or to multiple zones at a time.

The SOP can vary subject to the requirement of Chief Operating Officer. This shall be specified at the time of Completion of Commissioning and is included in part of vender software and hardware programming.

2.0 AMPLIFIER RACK

The amplifiers and associated equipment shall be housed in a standard 19" rack with plexi-glass door, located as shown on drawings. Ventilation panels shall be provided between every amplifier mainframe for proper air circulation and cooling. Proper exhaust fans shall be provided to achieve proper ventilation.

2.1 Amplifier Mainframe

The amplifiers shall be of modular construction with preamplifiers pluggable onto a mainframe. Upto ten preamplifiers could be added as required providing microphone, line, alarm tones, etc. Control over the total mainframe shall be achieved through audio monitoring combiners. The motherboard shall also be capable of accepting switch selectable pre-announcement chimes.
The power rating of the amplifiers shall be 160 watts, 320 watts or depending on the loudspeaker load requirements. No amplifier shall be loaded more than 80% of its rated capacity. Slave amplifiers shall be used to meet additional power requirements.

The amplifiers shall have the following technical characteristics or as per BOQ:

Output power	240W/120W/Per BOQ

Nominal RMS	100 W or 200W/Per BOQ
Long Term Power	(100V) 160W / Per BOQ
Output Voltage	100V
Frequency Response	60 Hz - 20,000 Hz
Speaker Outputs	6/8 Ohms
Inputs	2: Paging / BGM
THD @1 KHz.	<1%
SNR	=74dB
Sensitivity	-10dBm, 245m Volts
AC Input	220V, 50 Hz
Operational temperature	-20 to 45 deg C
Separate Tone Control	Bass and Treble

3.0 MICROPHONE INPUT MODULE

The module shall be a basic general purpose low impedance balanced microphone input, with a selectable phantom power facility. Output shall be available on bus and individually, separate bass and treble control and also relay controlled priority shall be available

It shall have the following specifications or as per BOQ:

Input impedance	:	-60dB (775uV)/200 Ohms maximum.
Frequency response	:	30Hz and 20 kHz 0.5dB.
Output	:	0dB/47k
Signal/noise ratio	:	55dB max. sensitivity, 150 Ohms source
Bass Control	:	15dB at 50 Hz.
Treble Control	:	15dB at 15 KHz.
Distortion	:	< 0.1% at nominal output 1 kHz, max. sensitivity

4.0 BALANCED LINE INPUT MODULE

The balanced line input module shall be a general purpose balanced 600 Ohm input with relay controlled priority.

It shall have the following specifications or as per BOQ:

Input Aux	:	-10dB (245mV) /10 K Ohm
Output	:	0dB / 47 K.
Input impedance	:	15k Ohms (300mV), 100k Ohms (100V).
Frequency response	:	30 Hz to 20 kHz
Bass Control	:	15dB at 50 Hz.
Treble Control	:	15dB at 15 kHz.
Distortion	:	<0.1% at nominal output 1 kHz, max. sensitivity

8.0 MIXER AMPLIFIER

The local amplifiers for the meeting rooms shall be rated 50W to drive the loudspeakers in the area. It shall be a full feature integrated amplifier with two mixable inputs, front panel activity indicators, integral fault monitoring, bass and treble control and shall be rack mountable. It shall be possible to add slave amplifiers for additional power requirements.

The amplifier shall have the following characteristics or as per BOQ:

Input	:	220 / 240V, 50 Hz
Output regulation	:	<2dB
Distortion	:	<1%
Frequency response	:	60 Hz-20 kHz
SNR	:	74dB
Sensitivity Input	:	-10dB (245mV) 47K Ohms.

Power rating (Nominal) : 50W or 100W

9.0 LOUDSPEAKERS

Loudspeakers shall be installed in the areas to achieve a uniform sound pressure level. The loudspeakers shall be mounted on walls, ceiling or in ground to meet the site requirements. All Parking/External area loudspeakers shall be weatherproof type. Speakers shall only be from the same equipment manufacture.

All loudspeakers shall have 100V line transformer to match 100V amplifier outputs.

The loudspeakers, including horns if used, shall provide music quality reproduction with a frequency response up to at least 18,000 Hz.

The specified power ratings of the speakers are the maximum values and no speaker is expected to be tapped at the maximum rating.

9.1 Sound Projectors

The sound projectors shall be used for landscape areas. It shall have a frequency response of 150 Hz-16 kHz and a maximum power rating of 30 watts.

The transformer shall have tappings of 15, 8, 4.0 and 2 watts at 100 volts. The SPL shall be 92dB, 1watt, 1m and the dispersion angle shall be at least 150 deg.

The speaker shall be dual cones wide band silicon treated.

The speakers shall be of weatherproof construction in aluminium alloy extruded body and front grill shall be perforated aluminium, with fixing brackets for angled positioning.

9.2 Ceiling mounted Loudspeaker

The ceiling loudspeaker shall include a 180 mm high compliance loudspeaker, 100 volt transformer and baffle.

The loudspeaker shall have a dispersion angle of 140 deg, a frequency response of 100 Hz – 18 kHz and a maximum power rating of 6 watts. The SPL shall be 90dB @ 1W, 1M.

The transformer shall have power tapping of 6, 3, and 1.5 watts at 100 volts.

The speaker shall be dual cones wide band silicon treated. The same speaker shall also be suitable either for public areas or humid and steamed rooms.

The baffle shall have a diameter of 180mm and be finished in baked white enamel with a sculptured modern contoured shape. Construction shall be of welded steel to prevent vibration and rattle.

The speaker shall be white RAL 9010 epoxy coated with all aluminium grill and chassis to withstand to avoid corrosion.

The baffle shall utilize a torsion spring fixing for installation with mounting ring.

9.3 Compact cabinets (W/P)

The weatherproof compact cabinet shall have a frequency response of 100 Hz-18 kHz and a maximum power rating of 16, 8, 4 or 2 watts as required for the area to be covered. The SPL shall be 92dB, 1 Watt, 1m.

The speaker shall be dual cones wide band silicon treated.

The construction shall be of moulded ABS plastic with aluminium grill and shall be black in colour. The unit shall include fixing brackets for angled positioning.

9.4 Spherical Speaker

The spherical speaker shall be an omni-directional speaker, which shall be white in colour and manufactured of ABS plastic. Mounting shall be via a Pendant and the speaker shall be supplied with a metal briaded cable.

Rated Power	:	6-20Watts
SPL@1m, 1 Watt	:	94dB
SPL@ Full Power,1m	:	107dB
Dispersion	:	140 (Vertical), 360 (Horizontal) Degrees
Dimensions	:	368 x 98 x 90mm
Frequency Range	:	80 – 18 kHz

10.0 INTEGRATION

Emergency Voice Evacuation system shall be integrated with Fire Alarm system and Building Management system for sequential operations and status monitoring.

10.1 Functions:

a. During normal conditions, these systems play music in common area and can be used to page people and to make public announcements.

b. In case of fire, a signal from fire alarm panel shall initiate announcement of pre-recorded message in all the groups/zones. This has the highest priority.

c. To avoid panic in the entire building, manual announcements shall be made to be restricted to the affected areas through the PA system.

d. If any additional hardware is needed, it should be specified and given with the software.

END OF SECTION

Section-19: Nurse Call System

PART-I GENERAL

1.1 REFERENCES

Standards applicable to the region.

1.2 RELATED REQUIREMENTS

Electrical General Requirements

1.2 SYSTEM

1. The scope of work consists of supply, installation, programming and commissioning of a nurse call system as shown on drawings and described herein.

2. [The new nurse call system shall consist of components compatible with and integrated with the existing nurse call system.

3. Contractor is responsible to inspect site prior to commencement of work to determine which parts of the existing infrastructure will be utilized.

4. Where identified on the drawings, pillow speakers will control overhead lighting.

5. Equipment shall be located in communication rooms, in occupied areas as noted on drawings and/or as called for in these specifications, any change to these locations shall be approved by the Consultant prior to installation.

6. System hardware shall consist of a nurse/patient communications network comprised of patient stations, dome lights, nurse call corridor displays, pillow speakers, call cords, pull cord stations, emergency push button stations, patient presence buttons, wiring and other options such as bed side-rail interfaces, computer interfaces, printer interfaces, wireless/telephone network interfaces for staff to staff communications, as shown on drawings. System to be complete with all necessary equipment required to meet the intent of this specification, whether or not each and every item is necessarily mentioned, to provide a complete and operating nurse call management network system. System to be supplied and installed by an established communications contracting firm that is approved by the Consultant.

7. Call management/systems integration suite to handle routing of patient calls and text messaging to wireless phones, to deliver room status information to the Hospital information system network and to allow the Hospital information system to deliver programmable inputs which activate auxiliary nurse call and wireless phone functions such as room cleaning request.

8. The system shall be interfaced to the staff to staff communication system to provide functionality as described herein.

9. All devices and interconnections are considered operationally critical and therefore are to be powered from essential electrical systems.

1.3 QUALIFICATIONS

1. Authorized Distributor for product supplied: Authorized Distributor Letter from manufacturer required upon request of specifying authority.

2. Applicable licenses.

3. Certificate of successful completion of manufacturer's installation/training school for each and every one of the installing technicians of the equipment being proposed.

1.4 SUBMITTALS

1. Provide submittals

2. As-built Records and Drawings:

   i. Confirm required format with the Minister prior to preparation of submittals.

   ii. Provide electronic drawings in [AutoCAD 2009] format depicting all as built conditions.

3. Provide two (2) bound complete hard-copy sets of as-built records to the consultant.

   i. Provide and place one hard copy of as-built records for each telecommunications room in plan holder in each telecommunications room. Plans to include a floor plan showing the location of all equipment such as head end equipment, clocks, and power supplies, labeling of all equipment and room numbers.

1.5 QUALITY ASSURANCE

1. Health and Safety Requirements: do construction occupational health and safety.

2. Contractor to employ knowledgeable staff trained to install the clock system according to the standards stated in the references above and the manufacturer's recommendations. The supervisor on site shall have sufficient knowledge and a minimum of five (5) years experience installing nurse call systems.

1.6 DELIVERY, STORAGE AND HANDLING

1. Stored and handle materials to ensure that their performance requirements are not affected by abrasions, dust or extreme temperatures.

2. Follow manufacturer recommendations for handling and storage to ensure that their performance requirements are not affected by abrasions, dust or extreme temperatures.

3. Do not bring nurse call system equipment to site until required for use and a suitable storage space has been identified.

1.7 SYSTEM REQUIREMENTS

1. System to be real-time networked based nurse call/call management system.

2. System to provide visual and tone annunciation, and two-way voice communication between the master stations and patient stations, staff stations and between these stations and wireless phones.

3. System to provide audio monitoring (one way) capability of patient room from master stations.

4. Allow multiple client PCs on the network to access an individual customizable display.

5. Flat panel monitor at each nurse desk shall be operated on by touch panel, mouse, keyboard or all of the above.

6. No nurse call failure can affect the network and no PC/network failure can affect the nurse call core system. All nurse call failures shall be captured in a maintenance log and all nurse call failures shall be sent via email to staff as designated by the owner.

7. Provide system to interface to a Bed Mapping Management system to be located at each Clinic Coordinator's desk as shown on drawings.

8. All station calls shall be controlled through a central control cabinet in the communication room(s) above in the interstitial space.

9. Calls to be individually annunciated at the nurse call master stations, on the nurse call display screens in charting alcoves and on nurse call display screens in corridors, indicating room number, and call classification. All calls to be individually annunciated on all tone stations and corridor display screens. All patient and staff calls to be annunciated on wireless phones also.

10. Caregiver to log onto wireless system through nurse call master stations and assign on-duty status for staff and their respective phone to be used.

11. Patient stations to incorporate safety call cord disconnect feature such that, if a call cord is removed from its socket, a priority call will be placed to master station. Call point will sound a continuous tone until the call cord is replaced.

12. System to be low voltage operation complete with individual power supplies, and memory battery backup.

13. Major components and connecting cable to all stations to be continuously monitored via satellite control operated software/hardware diagnostics on a per station basis to ensure the system's operational integrity.

14. Each room nurse call devices and associated room dome light to be capable of standalone operation.

15. All calls shall be capable of being automatically routed to wireless VoIP phones. Calls to be logged on server and routed to appropriate caregiver.

16. If calls are not responded to within a specified time, call to be routed to alternate caregiver's location or on caregiver's wireless phone. This is to continue until call is cancelled or acknowledged.

17. Per patient room, there shall be a consolidation point where all nurse call components are electrically connected. This consolidation point will connect to the nurse call network and will support all stations within the room, such as Lavatory Stations, Patient stations, Staff Emergency Stations, Patient Presence station, Dome lights, etc.

18. System to include nurse call management, reporting and logging software to record all time-based and keyed events. The system shall be capable of custom reports and be supplied with preconfigured detailed and summary reports. The system shall be able to export reports to standard software such as Microsoft Excel or Crystal Reports.

1.8 SYSTEM DIAGNOSTICS

1. All components in the system shall be continuously supervised for both power and data to ensure proper operation and in the case of system faults to aid in troubleshooting.

2. It shall be possible, from any designated network data interface location, on or off site, to diagnose all network active components, controllers, control stations, and sub-station operation. Network administrator shall be able to:

3. Review system faults report (i.e. control station, sub-station failure).

4. Place control station or network interface devices into interrogation mode for the purpose of running a diagnostic check of electronic components.

5. The Controller shall report faults or failure of assigned control, or network interface devices in plain English to its designated master stations.

6. Power Monitor To Provide

   i. "POWER FAULT" indicator
   ii. One momentary action "TEST" button
   iii. One momentary action "CANCEL" button
   iv. One speaker
   v. Locate in close proximity to main nurse call master.
   vi. Provide fault indication signal on nurse call system and wireless devices.

7. Chassis Monitor To Provide
   i. "CHASSIS FAULT" indicator.
   ii. One momentary action "TEST" button.
   iii. One momentary action "CANCEL" button.
   iv. One speaker.
   v. Locate close to main NC master console.

1.9 SYSTEM OPERATION

1. GENERAL

1. Call routing to wireless phone is simultaneous with annunciation at master station. Staff or emergency calls are routed as text notification (not voice) to wireless phones.

2. Priority 6 (normal) call shall perform the following functions:

   1. CODE 6

   1. The call assurance LED indicator on the patient station.
   2. The white section of the dome light shall steadily illuminate.

   3. The system monitor LED on all duty stations within the zone, shall flash at a rate of 15 ppm, indicating that a normal patient call has been registered in the system.

   4. The patient's room number, up to five digits, and bed number followed by the call indication shall appear in one of the four (4) display windows at the master station, dependent upon the number of previously placed calls, of equal or higher priority. If all displays are already illuminated this and all subsequent calls shall be held in memory until the preceding or higher priority calls are answered.

      i. An electronic tone shall sound at a rate of 15 ppm at all duty stations and master stations associated with the zone.

ii. Upon answering the call, all lights shall be extinguished and all tones silenced, the call shall be cancelled, and the room and bed number shall transfer a distinctive display, indicating what station has been selected.

3. Priority 4 (patient priority) call shall be the same as for normal call except:

1. CODE 4

1. The white section of the dome light shall flash at a rate of 30 ppm.

2. The system monitor LED on all duty stations within the zone shall flash at a rate of 30 ppm, indicating that a priority patient call has been registered on the system.

3. All tones shall sound at a rate of 30 ppm.

4. The call priority indication to be displayed at the master station.

5. The call shall only be cancelable at the patient station.

4. Priority 3 (Bathroom Emergency) shall be the same as priority calls except:

1. CODE 3

1. The LED shall illuminate that the call is placed.

2. The red section of the dome light associated with the room shall flash at a rate of 60 ppm.

3. System monitor LED indicator shall flash on duty stations and tone button on master stations within the zone.

4. The tones shall continue to sound at the master station and all associated duty stations at a rate of 60 ppm and continue to sound unless temporarily suspended at each location, or the call is canceled from the room by momentarily touching the cancel switch on the station originating the call.

5. The patient's room/bed number, if associated with the patient's room, or the room number with a priority indication to be displayed on the master station.

6. Staff emergency calls shall be originated from the patient's station by pressing the staff emergency button in the patient room. This call shall temporarily suspend but not cancel any other call already placed from the room, however, the call shall automatically and simultaneously perform the following functions:

1. CODE 1

1. Flash the RED section of the dome light at a rate of 120 ppm.

2. Sound a repetitive electronic tone at 120 ppm at all duty stations and master stations within that zone.

3. Flash the system monitor LED indicator on all duty stations at a rate of 120 ppm.

4. The patient's room and number, followed by the call priority (1) shall appear and flash in a display window on the master station.

5. Staff Emergency Stations shall be located in patient rooms, patient bathrooms and at locations indicated on the drawings.

7. The washroom and tub room station shall be provided with a "pull cord" station, each equipped with a cancel switch and call assurance LED indicator, all mounted on one-gang non-conductive wall plate. When a call is originated the following shall occur:

1. CODE 7

1. A normal call shall be placed by momentarily touching the call switch causing the following to occur:

2. The LED indicator associated with the switch shall steadily illuminate.

3. The amber section of the dome light, if used, shall steadily illuminate.

4. The tones at the master station, shall sound at a rate of 15 ppm.

8. The privacy, staff emergency switches and associated LED indicators shall be provided and function tested in the same manner as the patient station.

9. The duty stations will tone and will be located in all clean and soiled utility rooms. The control panel shall function as CODE 7.

1. The system monitor LED indicator shall flash at a rate determined by the type of call placed to indicate that a call has been placed on the system.

10. Multi-section dome lights suitable for wall or ceiling mounting, shall be provided outside the entrance to each patient room and all staff/duty rooms, clearly visible from all directions. The chassis, similar in design and material to the patient station, shall accommodate 1, 2, 3 or 4 long life, color coded lamps, separated by snap in metal barriers to meet the functional requirements of each room. The single-piece lens suitable for room number designations shall snap on to the chassis, allowing for quick and easy replacement of the lamps.

1. Lens cover caps shall be available in four (4) colors: White, Red, Amber and Green.

11. The master console shall be provided as a desk model and shall be capable of providing the following functions:

1. Receive and automatically answer all calls from patient stations in the order in which they were placed and by priority (1 through 6) or a per bed basis.

2. Receive and automatically answer all calls from staff stations in order in which they were placed and priority of call.

3. Receive calls from lavatory, shower and staff emergency on a priority basis, dependent on priority level and in the order placed.

4. Selectively answer or selectively originate a call to any patient, staff or duty station by touch dialing a 3 to 6 digit number corresponding to the Architectural room and/or bed number. The dial number shall be determined and pre-programmed by the hospital, via the touch dial keyboard at the master station.

.5 Program patient stations for emergency, priority and/or normal status calls.

.6 Digitally display a minimum of [four (4)] incoming calls, each having up to [five (5)] digits for room/bed identification, one digit for priority code, and

an indication whether it is an "original" call or a "recall" call. All other calls should be held in memory until answered. Systems displaying only one call shall not be acceptable.

.7 Automatic recall from the patient stations of those calls previously placed on reminder that have exceed the time limit (adjustable between 1 and 60 minutes).

.8 Capture one or more of seven masters.

.9 Communications with all area system via the keyless handset, speaker microphone or both.

.10 The incoming call tones shall be automatically silenced when answering calls, or temporarily silenced on a call basis, by depressing the tone switch. Whenever an additional call is originated the tone shall again sound.

.12 The attendant at the master station or using wireless phone, upon originating a call to the patient or answering a call from the patient, shall be able to communicate with that patient in one of the two following way:

.11 Through the wall station speaker/microphone without the patient having to raise his voice above normal level, direct his voice toward the station, or operation any controls in rooms.

.12 At any time communication is established, a privacy LED indicator on the patient station shall illuminate.

.13 A privacy-privacy switch when momentarily touched, shall illuminate the LED indicator and prevent the attendant at the master station from overhearing conversation from the room when originating a call to the patient's room. To temporarily suspend this mode of operation, the patient shall momentarily depress the call button, allowing the attendant to converse with the patient. Once the call has been concluded, the privacy mode of operation shall be registered automatically. If the patient originates the call, the privacy mode shall be automatically temporarily suspended, allowing the attendant at the master station to answer the call and established two-way voice communication with the patient, without the need for patient to again touch the call button. The privacy function shall be disabled by again touching the privacy switch, extinguishing the LED indicator. Privacy programmed or released from the master station shall not be acceptable.

.14 A cancel switch, when momentarily touched shall cancel any type of call placed from the patient station. The LED indicator with the switch shall illuminate any time the station is being monitored by/or in communication with the master station.

1.10 NURSE CALL INTEGRATION WITH STAFF TO STAFF COMMUNICATION SYSTEM

.1 Provide nurse call integration to staff to staff communication system.

.2 Nurse call integration with wireless IP phones must be tested and results must be provided to and approved by Consultant.

.3 Provide as required telephone line interface units, each with the ability to link three, two-way analog telephone lines for staff use to bedside control stations via existing wired or wireless telephone systems.

.4 Allow for staff to receive calls on wireless phones from either staff or patients.

.5 Staff shall be able to see room numbers, priorities of incoming calls and select the call they wish to answer, or to automatically answer the highest priority/oldest call or "quick" dial-in to the room using a shortcut routine.

.6 Staff shall be able to send wireless messages from a touch-screen console a computer on the hospital's LAN to the wireless phone.

.7 Ability for wireless phone to signal that another call is coming in while staff member is in communication with a room.

.8 Ability on a per staff member basis to filter only selected call priorities to route to the phones.

.9 Systems that allow staff to remote answer patient calls but do not provide semi-private staff-to- patient conversations for patient confidentiality with will not be acceptable.

1.12 SCHEDULING

.1 It is the responsibility of the contractor to coordinate all work with the other trades for scheduling, rough-in, and finishing all work specified. The owner will not be liable for any additional costs due to missed dates or poor coordination of the supplying contractor with other trades.

PART-II PRODUCTS

2.1 MANUFACTURERS

.1 All equipment is to be from a single manufacturer for a uniform system.

2.2 NURSE CALL NETWORK WIRING

.1 All Nurse Call Network wiring shall be only Category 6. System shall be capable of injecting DC power into a Category 6 run, for additional rooms, or long runs, by running a separate DC cable pair to a remote location.

2.3 AREA CONTROL UNITS

.1 Equipment to provide automatic switching, storage, logic, signaling, and interconnection circuitry required to provide specified nurse call functions and be mounted in a suitable cabinet complete with hinged locking cover.

.2 Equipment to be completely solid state, using integrated circuits, and other semi-conductor devices for all service functions.

.3 Equipment to provide bi-directional data and audio between associated stations and to the nurse call network.

.4 Equipment is to provide a minimum of [3] simultaneous voice paths per master station. Total number of supported voice paths is [3*] number of master stations.

.5 The switching, storing, amplifying and signaling circuitry to be mounted on modular printed circuit boards and contain the following:

.1 Solid state flasher circuitry and tone generators to provide a source of intermittent visual and audible annunciation.

.2 Solid state audio amplifier with independent talk/listen controls. Voice switching to be performed by a transistorized switching circuit. Sensitivity control to be provided to set level of operation.

.6 Power Supplies

.1 Power supplies to be provided for each central equipment unit.

.2 Units to provide all operating power to nurse call system. Plus 30% spare capacity.

.3 Power supplies to be designed for continuous duty operation, overload protected, filtered and regulated so that emergency AC supply transients do not affect system operation.

.4 Power to be restored automatically upon removal of an overload without resetting or replacing circuit breakers or fuses.

.5 Provide battery backup for control unit to ensure continuous operation in the event of a power failure for a minimum of 5 minutes without loss of system function or operational limitations.

.6 Power supplies shall be connected to 120VAC emergency power.

2.4 MASTER STATIONS / CONSOLE

.1 Master stations to provide:

.1 Direct, two-way voice communication with other master stations and wireless phones.

.2 Ability to carry [3] simultaneous speech channels.

.3 Visual indication of call classification and call origin.

.4 Audible indication of incoming calls with distinction of signal between differing levels of call priority.

.5 Answering of a calling station by acknowledging prompts on touch screen.

.6 Storing of calls with retention of each call until answered or cancelled.

.7 An override feature to preempt and hold incoming and stored calls.

.8 Nurse reminder capability.

.9 Visual indications of calls placed on system in order of priority.

.10 Capability to display visual indication for other master station calls if zone capture feature activated.

.11 Ability to program wireless phones with information pertaining to user, area of coverage, etc.

.12 Shall have capability to provide staff paging.

.2 Master stations to be self-contained desktop units, completely solid state and contain:

.1 Custom configurable, fully programmable Touch-screen alphanumeric display, particular to current installation.

.2 Telephone type handset with a long coil cord.

.3 Touch dial keypad for encoding room numbers, bed designations and selecting features.

.4 Ability to add extension sounders where alert tone volume is unable to penetrate isolation rooms or other remote areas.

.5 Volume control to regulate level of incoming audio.

.6 System call transfer capability to associated pre-designated master station.

.7 Solid state sounder for reproducing alert tones with separate and distinct audible classifications.

.8 Remote visual/graphic digital display interface for remote using of calls on system.

.9 Staff programmable for wireless telephones.

.10 Allow for relocation of station within 25 meters of location shown on drawing without additional costs. Final locations to be determined with successful contractor on-site with Owner and Consultant.

2.5 NURSE CALL CORRIDOR DISPLAY (ND)

.1 To be located at nurse charting alcoves and in corridors as depicted in drawings.

.2 Nurse call Corridor Displays (ND) shall have:

.1 Full alphanumeric English display.

.2 Ability to change display color of each type of call priority at each display.

.3 Ability to set rates of flash dependent upon priority of call event.

.4 Messages beyond the length of the display shall scroll from left to right and bottom to top.

.5 Displays shall be configurable from any Nurse Call Master or remotely through a network interface.

.6 Shall operate off of essential emergency power.

.7 Shall be viewable from both sides and positioned for line of site viewing along corridors (perpendicular to wall).

.3 Nurse call system/call management integration suite to include capability of custom corridor displays which would provide graphic of area floor plan with flashing colour of any room activated in staff emergency or code blue mode.

2.6 PATIENT STATIONS

.1 Provide single patient stations as indicated on drawings.

.2 Patient stations to provide:

.1 Automatic annunciation at master station should call cord be accidentally or intentionally removed.

.3 Patient station to be completely solid state and contain:

.1 Formed rigid chassis, subpanel circuit board and a non-conductive high impact plastic faceplate.

.2 Rigid printed circuit board with electronics and precoded plug-in terminals for ease of installation and maintenance.

.3 LED that indicates a call placed or received on the system.

.4 Call cancel switch.

.5 Speaker/microphone for 2-way communication and 1-way audio monitoring of any desired. Communication path to be established by call placed from within room, or by dialing room number from master console. Audio into the resident room is required to have the ability to be muted as required.

.6 Patient's bed number, room number, call indication should appear at nurse call master display window which will depend on priority level of calls. If all displays are already illuminated, subsequent calls are to be held in memory until the preceding or higher priority calls are answered.

.7 Shall be non-conductive, resistant to impact, built of flame self-extinguishing material, and reinforced. Station controls to have wear resistant overlay.

.8 Shall have electrostatic discharge protection of no less than 100,000Volts.

.4 Patient stations to accept any auxiliary call cords specified. Cords must be integral to the patient station and not require a special adapter.

.5 Shall provide at least 19 programmable call levels.

.6 Provide 6 spare single patient stations.

2.7 EMERGENCY LAVATORY PULL CORD CALL STATIONS

.1 Station to consist of waterproof plastic lead, pullcord, 10kg weak link break point, LED call lamp, built of flame self-extinguishing material, reinforce complete with high impact white polycarbonate plastic faceplate. Pullcord to be 1000 mm long with green or red 20 mm x 100 mm labeled pendent. Station controls to have wear resistant overlay.

.2 Shower emergency stations shall be provided inside the shower stall at the shower head-end. They shall be provided approximately 460 mm from the showerhead itself and/or 1830 mm above finished floor (AFF). Each station inside shower and toilet areas shall be equipped with a rubber gasket between the face plate and wall or be rated by UL as waterproof. The gasket shall cover and water seal the entire back box opening and not extend beyond the sides of the associated faceplate by 6.4 mm (1/4 inch) maximum. If the wall is tile or other uneven type material the gasket and associated faceplate shall be provided to completely seal the opening and uneven material surface.

.3 Call lamp to illuminate when cord switch is operated to verify that a call is registered on the system.

.4 Cancellation of call by pressing the cancel button.

.5 Station to be flush mounted installed with gaskets, rubber bushings, etc. for waterproofing.

.6 Weatherproof units to have isolation link as per Canadian Electrical Code and to be approved for installation with shower stalls prior to tender.

.7 Provide 6 spare emergency lavatory pull cord stations.

2.8 STAFF EMERGENCY STATIONS

.1 Each station is to be equipped with:

.1 A large red pushbutton pad

.2 A red call assurance light

.3 A reset switch

.4 Provide 6 spare staff emergency stations.

.5 Shall be housed in single gang chassis and will be non-conductive, resistant to impact, built of flame self-extinguishing material, and reinforced. Single gang wall plate is to be inscribed with "STAFF EMERG" in bold capital letters. Station controls to have wear resistant overlay.

2.9 CODE BLUE STATION

.1 Provide Code Blue stations as identified on drawings.

.2 Shall be housed in single gang chassis and will be non-conductive, resistant to impact, built of flame self-extinguishing material, and reinforced. Station controls to have wear resistant overlay.

.3 Shall contain a large pressure sensitive push button labeled code blue and a smaller cancel push button.

.4 Shall have a call assurance LED that illuminates whenever a call is placed.

.5 All external connections to be made by prewired, color coded, plug-in connectors.

.6 Provide 2 spare code blue stations.

2.10 TOUCH SCREEN STATION

.1 Provide Touch Screen stations as identified on drawings.

.2 The [15"] touch screen shall be configured to operate initially as a staff emergency pushbutton only. This virtual nurse call point will interface to the Nurse Call Master station.

.3 The display shall be resistant to cleaning chemicals and abrasive wear.

.4 If a computer is required, the CPU component of this system shall comply with the Minister's Desktop computer standard and shall be mounted a minimum of 2100mm AFF, be fastened to wall, and its associated cabling neatly wrapped. Provide appropriate backing on walls to support unit(s).

.5 The station shall incorporate the ability to make calls to wireless VoIP handsets.

2.11 PATIENT PRESENCE STATIONS

.1 Provide Patient Presence Stations as identified on drawings.

.2 Each station is to be equipped with:

.1 Three color-coded pressure sensitive electronic switches each with an embedded LED. The switch and LED will activate when the respective button is pushed and deactivate when pushed again.

.2 Single gang wall plate inscribed with "Patient Presence" in bold capital letters.

.3 All stations are to be either flush mounted, flush mounted on Q-Panels or flush mounted on patient service panels, in accordance with location shown on drawings.

.4 Staff Presence must be interfaced to bed mapping system such that when pressed, the room is shown as occupied on the mapping system.

.5 Shall be housed in single gang chassis and will be non-conductive, resistant to impact, built of flame self-extinguishing material, and reinforced. Station controls to have wear resistant overlay.

.6 Provide [6] spare patient presence stations.

2.13 DOME LIGHTS

.1 Provide Dome Lights as identified on drawings.

.2 Each dome light shall be complete with:

.1 An injected molded, high impact, heat resistant snap in translucent polymer plastic cover with mounting ring and appropriate metal black plate.

.2 A two (2)-gang wall plate.

.3 Concealed mounting hardware.

.3 Dome lights shall provide multi indications, with provisions to install four (6) colored lamps and shall be either wall mounted or ceiling mounted in accordance with locations shown on the drawings. The lamps shall have a standard commercial bayonet base and shall operate on the nurse call direct current power source.

.4 Corridor Intersectional Dome Lights:

.1 Provide corridor intersectional lights that contain a minimum of two lamps to identify any placed call in the System. The visual signals for routine and emergency placed calls shall be distinctly different from each other.

.5 Provide [2] spare Dome lights a [1] spare Intersectional Dome Light.

2.14 TONE STATIONS

.1 Provide tone stations at each corridor display location to provide audible annunciation of calls in corridors. If possible, tone stations shall be an integral part of the corridor displays.

.2 Tone station to have adjustable tone level control with a volume off (mute) function.

.3 Tone station to be able to be controlled by master station.

.4 Provide [2] spare tone stations.

2.15 NURSE CALL SERVER RACK

.1 Provide server rack to house nurse call server(s) and associated peripheral equipment.

PART-III EXECUTION

3.1 SUPERVISION

.1 Only factory certified installers shall install, service, and maintain the specified network system.

.2 Manufacturer shall have the equipment manufacturer's engineer or their designated agent inspects the installation and operation of this network to determine that the network complies with all standards specified herein.

3.2 WIRING

.1 Contractor shall terminate all wiring with manufacturer approved connectors. The use of wire nuts is prohibited.

.2 All wiring shall be free from shorts and faults. Wiring shall be UL listed, NEC and NFPA 70, Article 25 approved.

.3 Nurse patient communications network wiring shall not be run in the same conduit with other systems (i.e. Class 1 AC power distribution, fire alarm, entertainment systems, lighting controls, etc.).

3.3 INSTALLATION

.1 The System shall be delivered free of engineering, manufacturing, installation, and operating defects. It shall be engineered and installed for ease of operation, maintenance, and testing.

.2 The contractor will coordinate work activities with the Staff to Staff and WLAN systems. When complete, the nurse call system shall be fully integrated per aforementioned specifications and per additional interface requirements outlined in the Staff to Staff and WLAN specifications.

.3 The total System shall be designed and installed so that the installation, interfacing, integration, combining, and/or consolidation of equipment actually employed does not produce any undesirable visual or aural effects such as signal distortions, noise pulses, glitches, audio or video hum bars, transients, ghosting, etc.

.4 The contractor shall review site and establish additional Electrical Contractor needs (power, junction boxes, conduit, cable, etc.) in written form on the contractor's letterhead. These requirements are to be submitted to the consultant for review and issuance of a change order to the Electrical Contractor.

.5 The original equipment manufacturers (OEM) recommendations and guidelines shall be followed. The OEM and Contractor shall ensure that all management, sales, engineering, and installation personnel have read and understand the requirements of this specification before the System is designed, engineered, delivered, and provided.

.6 All equipment and materials used in providing the System shall be listed, labeled and certified by CSA or a provincially recognized testing laboratory where such standards have been established for the utilized items. Such listing and labeling shall warrant that the equipment has been tested in accordance with, and conforms to the specified standards.

.7 Backup power supplies (e.g., batteries, UPS) shall be installed in the central equipment cabinet or in a separate metal cabinet equipped with a hinged door and lock. If a separate cabinet is installed, it shall be provided adjacent to the central equipment cabinet. Where the backup power supply is already self-contained in a housing, the unit can be mounted adjacent to the respective equipment cabinet. In all cases, backup power supplies must be

permanently mounted. Each UPS and/or backup power supply shall be provided with full electrical supervision as described herein.

.8 Selection of type of cable to be at discretion of contractor but the system, when complete, must perform to the complete satisfaction of the Consultant and must be free of all interference from feedback, cross-talk, hum, switch and relay noise, etc. All wiring to be terminated in terminal strips or blocks, and to be neatly installed, laced and tagged where required. All terminals in terminal panels and junction boxes to be made with solderless connectors to terminal blocks with a separate terminal for each conductor.

.9 Ensure the proper bend radius is maintained for each wire or cable as specified by its OEM.

.10 Wires and cables shall enter each equipment enclosure, console, cabinet, or rack in such a manner that all doors or access panels can be opened and closed without removal or disruption of the cables.

.11 Wires and cables shall be insulated to prevent contact with signal or current carrying conductors and be 100% shielded. Wires or cables used in assembling consoles, panels, equipment cabinets and racks shall be formed into harnesses that are bundled and tied. Harnessed wires or cables shall be combed straight, formed and dressed in either a vertical or horizontal relationship to equipment, controls, components or terminations.

.12 Distribution cables shall be installed and fastened without causing sharp bends or rubbing of the cables against sharp edges. Cables shall be fastened with hardware that will not damage or distort them.

.13 Completely test all of the cables after installation and replace any defective cables.

.14 Outlet Boxes: Signal, power, interface, connection, distribution, and junction boxes shall be provided as required by the system design, on-site inspection, and review of the contract drawings.

.15 Back Boxes: Back boxes shall be provided as directed by the OEM as required by the approved system design, on-site inspection, and review of the contract drawings.

.16 Wire ends shall be neatly formed and where insulation has been cut, heat shrink tubing shall be employed to secure the insulation on each wire.

.17 Each connector shall be designed for the specific size cable being used and installed with the OEM's approved installation tool. Terminate all wiring with manufacture-approved connectors.

.18 All nurse call wiring shall be continuous with no allowance for splicing.

.19 All nurse call wiring shall be run in its own dedicated conduit and wireways.

.20 Nurse call cabinets to be mounted to conserve room and to house all required components.

.21 The nurse call system shall be installed only by factory trained and certified personnel.

.22 Master station programming to be coordinated with the Owner.

.23 Where analog connections to the existing PBX are required and cannot be accommodated with the IP enabled PBX, they shall use existing spare analog phone cabling connections inside the communication rooms. Coordinate this with owner's representative. No additional cabling will be provided for home runs back to the PBX.

.24 Mounting Heights: see electrical drawings/ confirmed on site with Consultant.

.25 Enclosures shall be installed plumb and square. Each shall be permanently attached to the building structure and held firmly in place.

.26 The Contractor shall install labels on all cables at each side of all connections. The labelling shall be permanent. Labels shall be installed adjacent to each mechanical connector, pull box or break in the cable run.

.27 Check installation of all equipment and terminate all wiring.

.28 The contractor shall connect the nurse call system to the light(s), test & commission. This cabling has also been identified on the nurse call drawings within this package.

.29 Check identification of all equipment and ensure equipment is clean and dust free.

3.4 PROTECTION OF NETWORK DEVICES

.1 Contractor shall protect network devices during unpacking and installation by wearing manufacturer approved ESD wrist straps tied to chassis ground. The wrist strap shall meet OSHA requirements for prevention of electrical shock, should technician come in contact with high voltage.

3.5 CLEANING AND PATCHING

.1 It shall be the responsibility of the contractor to keep their work area clear of debris and clean area daily at completion of work.

.2 It shall be the responsibility of the contractor to patch and paint any wall or surface that has been disturbed by the execution of this work.

3.6 WARRANTY

.1 The warranty shall include all necessary labor and equipment to maintain the system in full operation for a period of one year from the date of acceptance.

.2 In addition, the equipment (parts) warranty for all core system components including control / switching equipment, power supplies, patient stations, sub-stations, and nurse consoles shall extend to a total of at least five (5) years. Warranty for ancillary devices such as pillow speakers and call cords shall extend to a total of at least two (2) years.

.3 Manufacturer shall provide, free of charge, product firmware/software upgrades throughout the warranty period for any product feature enhancements.

.4 Contractor shall maintain a service department, necessary spare parts, telephone answering services and call dispatching required to implement the service standard stated below as part of this contract.

3.7 TESTS AND ADJUSTMENTS

.1 Upon completion of system installation, tests to be conducted by the system installer to determined system conformity to the requirements of the specification. Tests to be conducted in presence of Consultant and/or his representative who may suspend or discontinue tests at any time performance is considered unsatisfactory. Resumption of testing to cover the previously untested elements and any completed elements at the discretion of the Consultant.

.2 All equipment or wiring provided by the system installer which test prove to be defective or operating improperly to be corrected or replaced promptly at no additional cost to the Owner.

.3 Provide a detailed description of the testing and adjustment procedures. Complete with a copy of all required tests and verification sheets.

.4 Verify that each component and device has been installed according to the manufacturer guidelines, is fully functional, and labeled appropriately.

3.8 DEMONSTRATIONS

.1 It may be necessary to utilize demonstration equipment to test the functional operation of the contractor's submitted equipment. Contractor will be notified of any demonstration dates and times. If such demonstrations are utilized, it will be the sole judgment of the owner and specifying authority to decide whether a contractor/manufacturer meets or exceeds the specification.

.2 All demonstrated equipment must be of a standard single manufacturer and meet the same required testing and conditions that are applicable to the manufactured equipment. Custom or modified equipment shall not be demonstrated unless approved by owner.

3.9 TRAINING

.1 Training schedule and location is to be established by Owner. Training periods will take place after building completion and prior to building occupancy. Provide a detailed agenda for operation and maintenance training program proposed. The Consultant shall approve the training schedule, format and content.

.2 Contractor to conduct training program for all nursing staff assigned to nursing units, as well as for any other staff that requires training including maintenance staff.

.3 Nurse Managers: designated nursing personnel to be trained to accomplish and understand all aspects of system operation.

.4 Maintenance: designated personnel to be trained to perform routine maintenance on the system.

.5 At minimum, the job site training shall consist of [10] sessions, which shall be presented within the final one (1) month period prior to the anticipated date of final nurse call acceptance. The total training program shall be provided in the form of 5 day shift training and 5 night shift training sessions in order that all required staff might be released to attend the sessions.

.6 Provide factory level user training for [3] owner-designated personnel as part of this award. This shall include tuition, travel, meals and accommodation costs.

.7 Provide factory level service training for [2] owner-designated facilities management service personnel as part of this award. This shall include tuition, travel, meals and accommodation costs.

.8 Contractor shall supply a CD-ROM based, fully interactive, Computer Based Training (CBT) program to facilitate user training and feature support. The program shall be customized to emulate the nurse call management system's actual configuration at the facility. Users may proceed through this program at their own pace. Personal training sessions can be saved by staff and be continued at a later time.

Section-20: CCTV System

1.0 IP BASED CCTV SYSTEM

1.1 SCOPE OF WORK

The scope of the work includes the installation, testing and commissioning the complete CCTV system as described herein and as shown on the plans. The system shall include NVRs, PTZ cameras, Dome Cameras, Box type cameras, PTZ controller, LCD screens, wiring, termination, electrical boxes, and all other necessary material for a complete operating system.

1.1.1 FIXED DOME / BOX TYPE IP COLOUR DAY/NIGHT CAMERA

The fixed camera should have the following features:

- Directly IP based without requirement of encoder.
- Day / Night camera. Should switch automatically to monochrome mode (black and white) at night.
- Imaging Device 1/3 inch complementary metal oxide semiconductor (CMOS) or charge Coupled Device (CCD) with wide dynamic range (WDR)
- Image Control with Automatic white balance (AWB), automatic back light compensation (BLC), automatic gain control (AGC)
- Iris setting should be auto/manual with definitions for sharpness, image quality and also time stamp and camera ID.
- Minimum Illumination should be:

  Color mode: F1.4 @ 0.1 lux (.01 fc)
  Black and white mode: F1.4 @ 0.04 lux (0.004 fc)

- Vari-focal CS mount lens 3.5mm to 50mm required
- Supported Video Compression should be H.264 and Motion JPEG (MJPEG)
- 704 x 576 @ 25 fps PAL (minimum required)
  1920 x1080 @ 25 fps PAL (maximum required)
- Should support dual Video Streaming with both streams originating independently from the camera
- Should support multicasting
- Should support Power over Ethernet (PoE) 802.3af
- Should provide at least two digital inputs and two digital outputs for hardwire integration.
- Camera should provide 802.1X authentication
- Camera should support at least 128 bit encryption using hardware-based Advanced Encryption Standard (AES)
- Multiple user access levels with password protection.

1.1.2 PAN/TILT/ZOOM DAY/NIGHT INDOOR/OUTDOOR COLOUR DOME CAMERA

The PTZ Camera should have the following features:

- The camera should be IP based.
- The camera should be true outdoor model suitable for use in Pakistan.
- It shall be a discreet camera dome system consisting of a dome drive with a variable speed/high speed pan/tilt drive unit with continuous 360° rotation.
- Imaging device should be 1/3 inch CCD and support both color and monochrome black and white. With 540 TVL horizontal resolution.
- Should provide 27x optical zoom and 12x digital zoom (minimum) with auto focus feature
- The camera should provide high-quality MPEG-4, MJPEG or H.264 compressed images.
- The camera should provide images @ 4CIF i.e. with a resolution of 704x576 pixels in PAL mode.
- The supported frame rate should be 30ips or 25ips in PAL mode.
- The camera should support two simultaneous streams
- Should support Day/Night mode and should switch automatically to monochrome mode at night with below 1 lux sensing at variable shutter speeds.
- Should provide super quick, 400° per-second pan and 200° per-second tilt speeds with 256 pre-set positions. Each pre-set position should support the programmable camera settings such including selectable auto focus modes, iris level, Low Light limit, and backlight compensation for each preset.
- Should support wide dynamic range (128x) appropriate for high contrasting environments
- Should support Automatic focus, automatic Iris control, gain control horizontal and vertical aperture control.
- Should be installed in a High-impact, weather-resistant dome enclosure
- Camera must provide at least 7 Inputs and 2 outputs that can be programmed individually. Inputs should be able to trigger an alarm condition. Outputs should be able to drive an external device.
- Should support intelligent privacy masking by providing 8, four-sided user-defined shapes, each side with different lengths; window blanking setting to turn off at user-defined zoom ratio; window blanking set to opaque gray or translucent smear; blank all video above user-defined tilt angle; blank all video below user-defined tilt angle .
- Should support at least 8 user-defined programmable patterns including pan/tilt/zoom and preset functions, and pattern programming through control keyboard or through dome system on-screen menu
- Should support a web interface utility for 5 simultaneous users when using MJPEG/MPEG-4 in uni-cast mode. When configured in multicast mode (MPEG-4), the camera should support an unlimited number of users.
- Should support On-screen display for time, date and location. The position of the display and text should be user definable.

- Should support On-screen display of compass heading and user-definable compass setup so as to indicate direction that the camera is looking in.

- Should support multi level password protection.

- Should support Secure Sockets Layer (SSL) 128 bit encryption

1.1.3 VIDEO MANAGEMENT AND RECORDING SYSTEM

The Video Surveillance Management platform should be optimized for applications to view, store, and manage real-time and recorded video in a networked environment. The system should use an open suite of URL-based programmatic interfaces to communicate with applications. The system shall provide a highly scalable and reliable platform to enable customized, network-based surveillance applications. The Video Surveillance Management platform shall include but not limited to the minimum of the following features/functions/specifications:

- The system shall display any combination of live and recorded camera feeds on multiple workstations simultaneously using an IP network.

- The system shall provide low latency video with high quality images and support H.264, MPEG-4, and Motion-JPEG compression schemes simultaneously.

- The system shall provide replication of individual video feeds at different frame rates for multiple users and other system processes.

- The system shall support simultaneous video feeds across multiple locations for centralized and decentralized storage, display, and distribution of video without limitation, but shall minimize load on video servers by streaming only the active video channels.

- The system shall be capable of streaming and recording video at different bit rates and variable frame rates up to full motion 25 fps (PAL) video on all camera feeds and shall support QCIF, CIF, VGA (640x480 pixels), D1 (720x576pixels) and 4CIF (704x576 pixels) camera resolution.
- The system shall provide the ability to remotely configure the cameras and shall allow configuration data to be imported from a spreadsheet.

- The system shall allow instant replay of video and will permit pausing of live video, forward and backward review of recorded video, and return to live viewing.

- The system shall manage storage of real-time video at any specified frame rate, duration, and physical location on the network.

- The system shall provide flexible archiving capability in terms of frame rate, duration, and location and shall utilize dynamic file allocation to ensure that the full duration of the selected video stream will be recorded, regardless of lighting condition, motion, or scene detail.

- System shall support access to the archived video, to seek to any point in the archive, to set the pre and post time, and to loop that segment of the archive.

- The system shall cater for redundant multi-site video storage. Meaning that the video feeds coming from the sites must be stored on primary and backup storage.

- The system shall provide a Management Console that shows the status of CPU, Memory, Disk Usage, and traffic analysis.
- The System shall support H.264 Compression Protocol and 128 bit encryption. The system shall provide diagnostic tools that support Simple Network Management Protocol (SNMP).

- The system shall provide for integration with other software applications through an open and published Application Programming Interface (API). Such applications shall include, but not be limited to, access control, video analytics, and other alarms and sensor inputs.

- The system shall be capable of running on a single physical server or distributed across the network, scaling to handle thousands of cameras and users.

- The system shall provide for or have the capability of interoperating with the functional modules providing the capability for multiple web-based display consoles to configure, manage, display, and control video throughout the IP network; multiple options to store video and audio; virtual matrix switching; client PC viewing; and, remote encoding and storage.

- The system shall be capable of simultaneously supporting 3rd party IP based cameras from a variety of different vendors.

The system shall provide the following administrator functionalities:

- Secure login
- Server, encoder, and camera administration
- Scheduled and event-based video recording
- User and role management
- Fine-grained activity reports and system audit
- Ability to push pre-defined views to any number of digital monitors with Virtual Matrix
- Ability to schedule to operator shifts, event filters, temporary views.

The operator workstations running as part of the Video Management System shall provide the following operator functionalities:

- Secure login
- Flexible video displays
- PTZ controls including presets and advanced camera options (e.g. focus, white balance, iris)
- Digital zoom and instant replay
- Create instant recordings, "Record Now"
- Client-side video enhancements (adjusting brightness, color, transparency, etc.)
- Instantly swap between live and archive video of the same camera feed
- Archive review and clipping
- Event notifications
- Ability to search archived video based on motion within a predefined window within the video frame
- Synchronize playback of multiple archives

Supported file format types shall include or as per BOQ**:**

- WMV - A standard file format for downloading and playing audio/video data or to stream data on a PC.
- AVI - A standard file format for storing audio/video data on a PC.MP2
- Clip (BWM) - A segment of video extracted from an existing stream-able archive.
- Digitally Signed Clip (BWX) - A segment of video extracted from an existing stream-able archive and signed with a digital signature to verify content has not been tampered with.

Operator Workstation:

- The minimum configuration of the Operator workstation PCs and the Video Wall PCs shall be or as per BOQ:

- workstation based on the new Intel® X38 Express performance chipset and the latest workstation-class dual core Intel processors:

- Intel's Core™ 2 Duo (2.83 GHz, 4 MB L2 Cache) or better
- DDR-2 800 MHz ECC

- Should include the following Components or as per BOQ:

  - 160 GB SATA 3 GB/s NCQ 7200, 1st HDD
  - Intel Core 2 Duo E6850 3.0 4 MB/1333 CPU
  - 2 GB (2x1 GB) DDR2-800 ECC Memory
  - 768 MB PCIe Graphics
  - Microsoft Windows XP Pro 32-bit OS

  - Graphic card: NVIDIA®, GeForce® FX 5700 Ultra, FX 5900 Ultra or FX 5950 Ultra, Matrox Parhelia™, ATI RADEON® 8500,9500,9800

- The Operator workstation PC and the Video Wall PC will be separate and the two applications will not be combined on the same PC.

The minimum configuration of the Management and Recording servers shall be:

- Rack mounted, high end server - Multi processor based on a latest Intel processor.
- Minimum 2 GB of RAM
- Network adapter 1000 Mbps Ethernet
- Standard sound card is optional and recommended.
- Minimum 750GB storage capacity for installation.
- Redundant Power Supply.

1.1.4 STORAGE REQUIREMENTS

The video storage system shall have following features:

- Recording of all the camera streams must be stored for the period of 30days on DAS, NAS or SAN.
- The storage media must be SATA drives or Fiber Channel drivers or Flash Drives.
- Minimum storage requirement is 64TB raw (The supplier to confirm the storage requirement as per number of cameras, pixel resolutions, video compression and number of recording days)
- The storage servers must have redundant power supply and meet high availability standards
- The storage should be RAID 5 configured for disaster recovery.
- Each recording unit/server should allow for internal storage up to 32 TB per recording unit so as to allow expansion if later required

CCTV Color LCD Monitor

- The Video Color LCD Monitor shall be high performance with high resolution.

- Its image signal input / output port terminal allow bridge connection.

- The Video monitor shall have operating controls & shall be mounted below or on side-front of its screen.

- It should have 450v lines Resolution and variable control Knobs to control contrast, V hold H-Hold & brightness.

- Push buttons switch to control power On / Off and separate LED pilot light.

- The video monitor screen size shall be 21 inches flat & square tube shall produce clear distortion less viewing all the way out to the edge and corners of the screen.

- It shall consist of S- video input / output connectors separated output. Input signal shall be 1.0V p-p and impedance 75 ohms.

- The power source shall be AC 198-264 auto and power consumption shall be not more than 36 W.

- It shall consist of Automatic Voltage selector (AVS) to level voltage fluctuation instantly and automatically.

1.1.5 INTEGRATION (OPTIONAL)

CCTV system shall be integrated with Fire alarm system, Emergency Voice Evacuation system, Access control system and Building Management system for sequential operations and status monitoring.

Section-21: Fire Alarm System

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Manuals, brochures, technical submittals and general provisions of the Contract, including general and supplementary conditions, apply to this Section.

1.2 SUMMARY

A. This section includes the intelligent addressable fire alarm and detection system for ensuring safety and asset protection.

1.3 DEFINITIONS

A. NOT USED.

1.4 SUBMITTALS

A. Submit the product information for approval and final documentation in the quantities listed.

B. Documents for Approval:

1. Bill of material
2. Technical specifications of all the material
3. Connectivity diagrams
4. Any variance (in case of deviation from the given specifications)

C. Final Documents: Record documentation to include:

1. Documents listed above.
2. Recommended spare parts list for start-up support
3. Instruction manual
4. Testing Certificates

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Engage a firm with at least 15 years experience in manufacturing fire alarm detection system.

B. Supplier is to have a local service team with available spare parts in Lahore, Pakistan.

C. Service personnel are to have at least 10 years in the installation, start-up and servicing of the said system.

1.6 WARRANTY

A. The manufacturer's standard warranty shall in no event be for a period of less than 36 months starting from beneficial use of the equipment. Submittals received without written warranties as specified will be rejected in their entirety. Maintenance during reliability period shall also be covered in the warranty section.

PART 2- SCOPE OF WORK

2.1 GENERAL

The contractor shall supply and test the complete fire alarm system as described herein and as shown on the plans. The system shall include Intelligent Addressable main control panel, Addressable smoke sensors, Multi/heat sensors, wiring, termination, electrical boxes, and all other necessary material for a complete operating system.

The supplier has to verify that complete installation shall confirm to the applicable sections of NFPA-72, NFPA-71, EN-54 and BS-5839.

The fire alarm system shall allow for loading and editing instructions and operating sequences as necessary. The system shall be capable of storing, and downloading while the system is in operation, a second set of operating software resident in the control panels as backup in case primary operating software is corrupted. In addition, the system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation. All software operation shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory.

Resident software shall allow for full configuration of initiating circuits so that additional hardware shall not be necessary to accommodate changes in, for instance, sensing of normally open contact devices to sensing of normally closed contact devices or from sensing of normally open contact devices to sensing a combination of current limited and non-current limited devices on the same circuit.

The system shall have the capability of recalling alarms and trouble conditions in chronological order for the purpose of creating an event history of 600 events.

The activation of any system smoke detector shall initiate an alarm verification operation whereby the panel will reset the activated detector and wait for a second alarm activation. If within one minute after resetting, a second alarm is reported from the same or any other smoke detector, the system shall process the alarm as described in the sequence of operation. If no second alarm occurs within one minute the system shall resume normal operation. The Alarm verification shall operate only on smoke detector alarms. Other activated initiating devices shall be processed immediately. The Alarm verification operation shall be selectable by zone.
A manual evacuation switch shall be provided to operate the alarm indicating appliances without causing other control circuits to be activated. However, should a true alarm occur, all alarm functions service conditions including the time of each occurrence.

The system shall have a single key that will allow the operator to display all alarm, troubles, and supervisory service conditions including the time of each occurrence.

The system shall have provisions for disabling and enabling all circuits individually for maintenance or testing purposes.

The system batteries shall be supervised for disabling and enabling all circuits individually for maintenance or testing purposes.

The panels shall be capable of networking upto 99 more nodes as nodes as and when required without modification of hardware except adding network cards.

2.2 SEQUENCE OF OPERATION

Upon actuation of any manual station, or automatic detector or sprinkler flow switch, or air conditioning and ventilation duct return and exhaust air smoke detector. The system is to operate as follows:

On the Main Panel the green normal LED is to extinguish and the red alarm LED is to light. The first line is to display the user specified message indicating the floor and zone that initiated. The first line is to display the user specification message indicating the floor and zone that initiated the alarm. The second line of the LCD is to indicating real time, number of messages waiting, type of alarm, zone of alarm and time the alarm occurred. Red LED corresponding to the zone in alarm in the main panel shall also be lit.

The alarm indicators on the FACP and repeater panel to continue to flash until the alarm is acknowledged . If a subsequent alarm is received after acknowledgment, the alarm is to sound again. The operator is to acknowledge the alarm by pressing a dedicated button and the buzzer is to silence provided that isn't an additional alarms the operator is to acknowledge all pending alarms before the buzzer is to silence. To reset the system the device is to be cleared first then the reset button is to be pressed.

The alarm shall consists a "slow whoop" alarm tone, for ten second. The tone shall repeat continuously (unless manually silenced) until the alarm initiating device is restored to normal and system reset. The silencing of an alarm condition is not to prevent the resounding of alarm devices if a subsequent condition occurs. A time delay feature is to be provided to sound a general evacuation alarm automatically throughout the building if the initiating alarm condition is not responded to within a predetermined time. Visual indication at the panels, corresponding to activated voice alarm circuits is to illuminate.

2.3 VOICE COMMUNICATION (OPTIONAL)

A central single channel digital audio control module shall be provided for the necessary alarm message / tone generation main and remote microphone connections, music inputs, and mixer / pre-amplifier circuits. Continuous supervision shall be provided along with specific information as to the type of failure should a problem occur (e.g. Main microphone trouble, tone trouble, etc.) Audio outputs shall have individual gain control.

A hand-held push-to-talk microphone shall be provided in the Voice Command Center, recessed within a protective panel-mounted enclosure. The microphone shall be a noise-canceling communication type with a frequency range of 200 Hz and shall be equipped with self-winding five foot coiled cable. An LED indicator shall be provided for the circuits ready for transmission. The microphone shall be supervised for disconnection.

Digital tones for alarm (show whoop) and auxiliary requirements (wail, horn, chime, etc.) shall be provided.

A pre-recorded digitized voice message capability is to be provided for automatic transmission to building occupants during alarm conditions. The automatic message player shall not rely on a tape or other mechanical means of transmitting the evacuation message. A standard evacuation message shall be provided under this contract, however, the message player must be capable of transmitting a custom message of up to five (5) minutes long. A self-contained speaker will provide testing of the message (s) without disturbing the occupants of the facility.

The system shall be configured to allow selective voice paging. Upon activation of any speaker manual control switch, two attention getting beeps shall sound over the speakers indicating an impending voice message will occur.

If any speaker manual control switchers are activated, the control panel operator shall be able to make announcements via the push-to-talk paging microphone over the pre-selected speakers.

Facility for total building evacuation and paging shall be provided to allow for activation of all speakers. This shall be accomplished by the means of an" All Circuit" switch.

2.4 POWER REQUIREMENTS

The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 230VAC power in a normal supervisory mode for a period of 24 hours with 30 minutes of alarm operation at the end of this period. The system shall automatically transfer to the stand-by batteries upon power failure. All battery charging and recharging operations shall be automatic. Contractor shall submit standby and alarm power calculations in support of the selected battery size. The batteries used for the system shall be maintenance free type.

2.5 FIRE ALARM CONTROL PANEL

The control panel shall be Intelligent Addressable type of adequate point capacity with 20% spare and the construction shall be modular with solid state, microprocessor based electronics. It shall display only those primary controls and display essential to operation during a fire alarm condition.

A local audible device shall sound during alarm, trouble or supervisory conditions. The audible device shall sound differently during each condition.

The following primary controls shall be visible through a front access panel:

- Eighty character liquid crystal display.
- Individual red system alarm LED.
- Individual yellow supervisory service LED.
- Silent Walktest with History Logging

The system shall be capable of being tested by one person. While in testing mode the alarm activation of an initiating device circuit shall be silently logged as an alarm condition in the historical data file. The panel shall automatically reset itself after logging of the alarm. The panel shall also be capable of giving an alert alarm in case if any addressable device is not in operation or requires maintenance.

2.5.1 LED Supervision

All slave module LEDs shall be supervised for burnout or disarrangement. Should a problem occur the LCD shall display the module and LED location number to facilitate location of that LED.

2.5.2 System Trouble Reminder

Should a trouble condition be present within the system and audible trouble signal silenced, the trouble signal shall resound at preprogrammed time intervals to act as reminder that the fire alarm system is not 100% operational. Both the time interval and the trouble reminder signal shall be programmable to suit the owner's application.

2.6 MULTIPLE ADDRESSABLE PERIPHERAL NETWORK

The system must provide communication with initiating and control devices individually. All of these devices will be individually annunciated at the control panel. Annunciation shall include the following conditions for each point:

- Alarm
- Trouble
- Open
- Short
- Device missing/failed
- Automatic environmental compensation.
- Variable Sensitivity setting
- Day & Night mode of operation
- Automatic dirty sensor indication

All addressable devices shall have the capability of being disabled or enabled individually.

Each loop to have a minimum capacity of 200 devices with detector & control modules in any combination. System that require factory reprogramming to add or delete devices are unacceptable. Each loop to have 25% spares available. Vendor to increase the no. of loops, if required.

Each addressable device must be uniquely identified by an address code interred for each device. The use of jumpers to set address will not be acceptable due to the potential of vibration and poor contact. The system must verify that proper type device is in place and matches the desired software configuration.

PART 3-ADDRESSABLE DEVICE TYPES

3.1 GENERAL

The system control panel must be capable of communicating with the types of addressable devices specified below. Addressable Devices will be located as shown on the drawings. The system shall identify when a smoke sensor becomes too dirty to operate properly. It shall also identify sensors which are almost dirty which need cleaning before they drift beyond their selected sensitivity. In short, a review of the front panel display or the printed status report quickly identify sensor that need cleaning.

Sensitivity of the sensor shall a programmable, photoelectric shall be variable from 0.2 to 37 percent and ionization sensitivity from 0.5 to 1.7 percent. It shall also be possible to programme for timed, automatic sensitivity selection such as less sensitive during working hours and more sensitive when quite.

The panel shall provide the following features:

- Individual sensitivity selection for each sensor
- Peak value logging allowing accurate analysis for sensitivity selection
- Automatic, once per minute individual; sensor calibration check to verify sensor integrity
- Display of sensitivity directly in per cent per foot
- Multi-stage alarm operation
- Ability to display and print detailed sensor information

3.2 ADDRESSABLE SENSOR BASES

The addressable sensor bases shall contain integral addressable electronics that constantly monitor the status of the detachable photoelectric, ionization or heat sensors. Each sensors output shall be digitized and transmitted to the control panel every four seconds.

It shall be possible to use different sensor types with the same base. The base shall have integral LED for power-on (pulsing), or alarm or trouble (steady on). The bases shall be available with connections for remote LED alarm indicator or connections for supervised remote replay. The sensor bases shall be size not more than 125mm diameter.

Address of the device shall be set in the base using dip switches so that removal or replacement of the sensor head will not affect the operation of the system. Device addressed through software or address set in the sensor head are not acceptable. Soft addressable sensors are also will be acceptable subject to compliance with other requirements of the specifications.

3.3 ADDRESSABLE OPTICAL SMOKE SENSORS

Optical sensor shall use a stable, pulsed infra red LED light source and a silicon photodiode receiver to provide consistent and accurate low power smoke sensing. Seven levels of sensitivity shall be

available for each individual sensor, ranging from 0.2% to 3.7% per foot of smoke obscuration. It shall be possible to select and monitor the sensitivity at the control panel.

The head be designed to allow 360 deg. Smoke entry for optimum response to smoke from any direction. A built-in screen shall keep insects from entering the smoke chamber.

3.4 ADDRESSABLE OPTICAL HEAT SENSOR

The addressable type heat sensor shall be self restoring and provide a combination of rate and fixed temperature rate compensated sensing. It shall have low thermal mass to accurately and quickly measure the local temperature at the fire alarm panel.

It shall be possible to select the rate of rise temperature detection for either 15 °F or 20 °F per minute. Fixed temperature sensing and shall be programmable to operate at 135 °F or 155 °F. It shall be possible to program these sensors as a utility device to monitor for temperature extremes in the range from 32 °F to 120 °F (optional).

3.5 INTELLIGENT OPTICAL MULTI SENSOR

The Addressable Multi Sensor gathers analog information from one photoelectric fire sensing element and one heat sensing element and converts it into digital signals. The sensitivity of the Device shall be variable. The Addressable code for the Device shall be electronically programmed and stored in the Sensor and be non-volatile. The programming of this code shall be facilitated by a digital electronic hand held Device.

- Sensitivity variable
- Operating voltage 24VDC
- Standby Condition ≤100µA
- Alarm Condition ≤7mA
- Transmission Method Digital Communications
- Maximum Humidity 93% RH- Non Condensing (at 40◦C)
- Temperature range -10◦C - + 50◦C
- Smoke Sensing Element: Photoelectric - Light Scattering Principle
- Heat Sensing Element: Fixed temperature alarms at 135°F (57°C) ambient

3.6 ADDRESSABLE PULL STATION

They shall be manufactured from high impact red lexan. Station shall mechanically latch upon operation and remain so until manually reset by opening with a key common to all system locks. Pull stations shall be double action type requiring smashing glass and pulling a lever to initiate an alarm.

The device shall integral electronics for constantly monitoring the status of the device and communicating the same to the control panel. Address of the device shall be set by dip switches in the associated electronics.

3.7 ADDRESSABLE DEVICE SUPERVISION

All devices shall be supervised or trouble conditions. The system control panel will be capable of displaying the type of trouble condition (open, short, device missing, failed).
Should a device fail it will not hinder the operation of other system devices.

3.8 NOTIFICATION APPLIANCES

Notification appliances shall include visible, audible or Audible / visible as shown in the drawing. Audible appliance shall be loudspeaker or dc vibrating bells and the visible appliance shall be strobes. The sounders must be capable of projecting the pre-recorded voice messages. The pre-recorded messages shall be in various languages i.e English , Urdu or any other as specified by the end user.

3.9 STROBES WITH SOUNDER (SINGLE UNIT)

Strobes shall be suitable for wall or ceiling mounting as shown in the drawings. Xenon flash tubes shall be 24VDC powered from the panel. Visible output shall be 30 candela. The reflective design shall provide light output in key axis directions allowing vertical or horizontal mounting. The unit shall be of red finish with white 'FIRE" lettering . Flash rate shall be 1 Hz.

3.10 INTEGRATION

Fire Alarm system shall be integrated with Emergency Voice Evacuation system, Access control system and Building Management system for sequential operations and status monitoring.

Section-22: GPON

PART 1 - GENERAL

1.1 DESCRIPTION:

A. The Work shall consist of furnishing and installation of voice and data communication cabling as shown on the drawings and specified herein.

1.2 REFERENCES:

A. ISO – International Standards Organization

ISO/IEC 11801 Information Technology – Generic Cabling for Customer

Premises

ISO/IEC TR 14763-1 Information technology – Implementation and operation of customer premises cabling – Part 1: Administration

ISO/IEC TR 24750 Information Technology – Assessment of installed balanced cabling channels in order to support 10 GBASE - T

B. IEC - International Electrotechnical Commission

IEC 60603-7 Connectors for Electronic Equipment – Part 7-1 & 7-7

IEC 60793 All parts relevant to these Specifications

IEC 60794 All parts relevant to these Specifications

IEC 61156-1 to 6 Multicore and symmetrical pair/quad cables for digital communications – Part 1 to 6

IEC 61935-1 & 2 Generic cabling systems – Specification for the testing of balanced communication cabling in accordance with ISO/IEC 11801 – Part 1 & 2

IEC 60332 Test on electric cables under fire conditions

IEC 60754 Tests on Gases Evolved During Combustion of Material from Cables

C. EIA - Electronic Industries Association

RS-453 Dimensional, Mechanical and Electrical Characteristics

Deferring Phone Plugs and Jacks

EIA 310 Racks, Panels and Associated Equipment

EIA/TIA 492AAAA Detail Specification for 62.5-UM Core Diameter/125-UM Cladding Diameter Class 1A Graded-Index Multimode Optical Fibers

EIA/TIA 526-14-A Optical Power Loss Measurements of Installed Multimode

Fiber Cable plant - OFSTP-14a

EIA/TIA 568 A Commercial Building Telecommunications Wiring Standard

EIA/TIA 568-B.1 Commercial Building Telecommunications Cabling

Standard, Part 1: General Requirements (ANSI)

EIA/TIA 568-B.2 Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted-Pair Cabling Components (ANSI)

EIA/TIA 568-B.3 Optical Fiber Cabling Components (ANSI)

EIA/TIA 569 Commercial Building Standard for Telecommunications

Pathways and Spaces

EIA/TIA 606-A Administration Standard for the Telecommunications

Infrastructure of Commercial Buildings

EIA/TIA 607 Commercial Building Grounding/Bonding/Requirement

Standard

EIA/TIA TSB 67 Transmission Performance Specifications for Field Testing of UTP Cabling Systems

EIA/TIA TSB 155 Additional Guidance for 4 – Pair 100 ohms Category 6

Cabling for 10 GBASE-T Application

D. IEEE - Institute of Electrical and Electronic Engineers

IEEE 802.3 AN 10 GBASE – T Standards 2006

E. ICEA - Insulated Cable Engineers Association

ICEA S-80-576 Category 1 & 2 Individually Unshielded Twisted Pair Indoor

Cables for Use in Communications Wiring Systems

ICEA S-83-596 Standard for Fiber Optic Premises Distribution Cable

1.3 SUBMITTALS:

A. General: Submit the necessary complete sets of documentation indicating type, size, rating, style, catalog number, Manufacturers names, photographs and / or catalog data sheets for all items to ensure compliance with Specifications. This documentation shall be subject to the approval of the Owner Representative and no equipment shall be ordered without his approval for all equipment and devices, which are shown on documents (drawings, BOQ, etc). During technical submittal stage, contractor shall submit all required technical document for study and approval.

B. Product Data: Submit manufacturer's technical product data, including:

1. Compliance sheet to the specification with cross reference to related items in data sheet, point by point, indicating deviations, if any, with reasons for such deviations, also indicate any extra features / specifications.

2. Complete one-line riser diagram(s) showing all system components

3. Pin to pin riser diagram showing all system components and interconnection between the system and all other related systems.

4. Complete description data including UL listing or any equivalent standards for all system components

5. Provide all system related calculations supported by manufacturer specific software and perform all necessary calculations validating the shop drawing system distribution and related installations.

6. Complete description of system operations and functions of each system component.

7. Manufacturer's technical product data sheets, including quantities and specifications of every item, specification of every device, system component, quantities, software and installations for each unit of equipment.

8. Contractor shall submit a list of the Manufacturer's authorized, local representative responsible for installation coordination and service, pre-qualification for the system provider and installer.

9. Complete description and data including related standards for all system components.

10. Documents indicating system expandability options included in the submitted products and system included redundancy features.

11. Documents indicating that the supplied system components are the latest and most updated products from the system manufacturer and software versions are the latest produced by the system manufacturer.

12. All technical material submittals must be provided in both hard copy and soft copy. The softcopy must allow for searching capabilities. The technical material submittal will be rejected if the softcopy was not included.

13. Testing & commissioning procedures according to system manufacturer requirements and calibration certificate for testing equipment

14. Configuration plan including all management plans to be implemented according to project operational team

15. Provide Bandwidth calculation sheets for all switches in the network

16. Verify and submit power consumption and heat dissipation calculation sheets utilizing system manufacturer software and make all necessary changes and adaptation on site without extra cost.

17. Submit Wi Fi Coverage patterns and accordingly modify, add, relocate wi fi outlets to provide full coverage of the building enabling VOIP over Wi Fi network in all building areas.

C. Shop Drawings: Provide shop drawings & Composite drawings showing equipment, device locations, labeling, part number and connecting wiring of the systems, including riser diagrams, rack elevations. Shop drawings shall include, but not be limited to the following:

1. Complete pin to pin one-line riser diagram(s) showing all approved equipment, size, type and number of all conductors, interconnection between the system and all other related systems.

2. Installation details for all system components. Installation details drawings shall show all accessories used in installation such as back boxes, glands, washers, etc.

3. Complete Grounding details as per system manufacturer requirements.

Indicating connections with dedicated grounding system including connections with telecommunication grounding bus bars as part of overall grounding and bonding system including telecom main grounding bus bar

4. Exact location of every single component of the system in coordination with all other works (Electromechanical, Arch., and Civil).

5. Colored Composite drawings for all MEP systems showing all coordinated

7. Complete sequence of operations and functions of the system.

8. All drawings should be submitted in both softcopy and hardcopy formats.

No of copies shall be according to contract documents requirements (at least three copies shall be submitted)

D. System supplier & Installer qualifications documents: System supplier & Installer should submit the required certifications indicating that the system supplier and installer company is certified from system manufacturer to perform all system supplying, installations, testing and commissioning supported by system installers CVs and related manufacturer certifications. The system supplier should be involved in a strong relationship with system manufacturer with proven reference of similar projects. The system supplier & installer should submit reference of similar projects and abide by all requirements in project documents (specifications, drawings ,BOQ, and method of measurements)

E. Manuals: Submit complete manufacturer Installations, maintenance and operation manuals including spare parts list for each system component, including furnished specialties and accessories. Include this data, product data, and shop drawings in the manuals in accordance with other relevant documentation.

F. Composite Coordinated drawings illustrating all MEP devices and equipment.

G. Documents indicating the working environment according to system manufacturer regarding temperature and humidity are achieved and coordinated with HVAC team.

H. Finalized Reflected ceiling drawings illustrating all works in the ceilings after finalizing the coordination process.

I. Testing & commissioning plan according to manufacturer testing procedures. Third party testing agency shall be nominated for the whole project

J. Wiring Diagrams: Show typical wiring schematics including workstation outlets, jack and jack assemblies, patch cords, patch panels, fiber-optic boxes and other equipment.

K. Samples: For workstation outlets (TO), jacks, jack assemblies, and faceplates for color selection and evaluation of technical features.

L. Close-out Submittal: Operation and Maintenance Data, spare parts, System record Drawings and wiring details, in compliance - PROJECT CLOSE-OUT REQUIREMENTS

1.4 TRANSPORTATION, HANDLING AND STORAGE:

A. Deliver equipment and components in factory-fabricated containers or wrappings, which properly protect equipment from damage.

B. Store equipment and components in original packaging. Store inside in a well- ventilated space protected from weather, moisture, soiling, humidity, and extreme temperatures.

C. Handle equipment and components carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged units or components; replace with new.

1.5 WARRANTY:

A. The manufacturer must guarantee to the End User that the products referenced within the specific Warranty Modules (Class E System) when correctly installed in accordance with installation guidelines:

1. Will be free from product defects in materials and workmanship

2. Supports the following application (not limited):

- 10BASE T Ethernet
- 100BASET Fast Ethernet
- 1000BASE TX Gigabit Ethernet
- 10GBASE-T
- 155Mbit ATM
- 1000Mbit ATM (CB1G)
- 10 GBASE-T

3. For a duration of 20 years

B. All components including the patch cords have to be produced by the same cabling system manufacturer to ensure warranted performances and applications against the standards.

1.6 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: The items provided under this contract will be from manufacturers that have a minimum of 5 years experience in producing the types of systems and equipment specified.

B. Installer Qualifications: Specialist subcontractor with at least 5 years of successful installation experience with projects utilizing data system similar to that required for this project. Subcontractor shall be subject to approval of Engineer.

C. Materials and installation shall comply with the specified Codes and Standards.

D. Single Source Responsibility: All components and accessories shall be product of single manufacturer except for cables unless approved by consultant.

1.7 ENVIRONMENTAL REQUIREMENTS:

A. Connecting hardware shall be rated for operation under ambient conditions of 0 to

50 degrees C and in the range of 0 to 95 percent relative humidity, non- condensing.

PART 2 – PRODUCTS

2.1 SYSTEM DESCRIPTION:

A. The voice and data communication cabling shall consist of horizontal and backbone cables and connecting hardware to transport data (including LAN/WAN) and voice (telephone) system signals between related as shown on drawings. Numbers of outlets shall be as shown on drawings and documents. The Data Local Area Network (LAN) Sub-Contractor shall coordinate his work with telephone equipment Sub-Contractor(if any).

B. The system shall support GPON Scheme.

C. The Data Network will perform all switching and routing functions for voice, video and data services and applications. The network shall serve all IP based services such as VOIP, IP CCTV, IPTV, etc, as applicable.

D. The Core Switches will be located at the heart of the network and shall provide very fast switching, intelligent high performance platform for deploying numerous concurrent intelligent services without degrading the overall performance of the network. The core switches shall perform various functions using various service modules for wan interfaces, security firewalls…etc. Core Switches should support MPLS and act as P-Routers.

E. Connectivity between DC Switches and Core Switches should be based on 40G/ per BOQ/Risers.

F. Connectivity between Core Switches and Distribution Switches should be based on 40G/ per BOQ/Risers.

G. The distribution switches will be used to provide aggregation for various services and filter traffic that will reach the network core. Each distribution switch shall be connected to each core switch via 40GbE link and the edge/Access switch will be connected to the distribution switch via 2x10GbE /per BOQ/Risers. The connections between each edge switch and the distribution switch must be on a different card on the distribution switch

H. Access Switch: Access Switches will be located per per BOQ/Risers/Dwgs.

K. Network Equipment Management Software: The management software's main function is to enable remote and centralized configuration of the different parameters and functions of switches and routers of the Data Network.

N. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.

1. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.

2. Bridged taps and splices shall not be installed in the horizontal cabling.

P. The maximum allowable horizontal cable length is 90 m. This maximum allowable length does not include an allowance for the length of 4.9 m to the workstation equipment. The maximum allowable length does not include an allowance for the length of 4.9 m in the horizontal cross-connect.

Q. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

R. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

2.2 GENERAL:

A. Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall be of latest technology/version available at the time of installation, and has been in satisfactory use for at least 1 year prior to installation. Materials and equipment shall conform to the respective publications and standards specified.

2.3 HORIZONTAL CABLING:

A. Horizontal Distribution Cable:

1. Horizontal distribution cable shall be Category 6.

2. The cable shall be a four, thermoplastic-insulated, individually twisted pairs of copper conductors; No.23 AWG, color-coded; enclosed in PVC jacket or a material.

3. Cable shall be designed to support the IEEE 802.3 1000Base.

4. All pairs must have impedance of 100 Ohms, with a tolerance of +/- 15

Ohms. In the construction of the cable cross-talk performance shall be maintained using a C3 (Central dielectric Cross-talk Cancellation) member set between the 4 pairs.

5. Insulators in standard Blue/White, Orange/White, Green/White, Brown/White colors must cover the conductors.

6. Cable shall be of latest technology/speed manufactured and available at the installation time.

7. Cable shall be used for horizontal run between data, voice (telephone), clock and security system outlets and floor communicable cabinet.

10. Meet the following electrical characteristics per consultant's recommendations (if any):

Max DC Resistance (@ 20°C) <8.5Ω /100m

Characteristic Impedance

(no impedance averaging allowed) 1-100 MHz: 100 ohms ± 15%

100 - 750MHz: 100 ohms ± 22%

Nominal Velocity of Propagation (NVP)

LSOH – 67%

11. Provide the following 100m, 4-connector topology performance (std ref. values in grey cells):

B. Telecom Outlets (TO): Category 6 RJ45 information outlets designed for termination of 4-pair balanced twisted-pair category 6 copper cable must possess the following characteristics at the minimum:

1. Exceed category 6A component compliance.

2. Telecom outlets shall be CAT 6 (UTP) RJ45.

3. Each connector shall provide both T568A and T568B color code identification for the pins at the rear of the connector.

4. The punch down is to be in accordance with the T568B color code.

5. Reassignment of pairs is forbidden.

6. All conductors from the CAT6 4 pair cable shall be terminated on the respective contacts.

7. Universal design allows the same outlet to be mounted in flat or angled orientation.

8. Have available termination tools.

9. Be backwards compatible to allow lower performing categories of cables or connecting hardware to operate to their full capacity.

10. Allow installation from the front or rear of the faceplate, and allow for the jack to pass through the faceplate without re-termination.

11. Provide color-coded, snap-in icons available for circuit identification.

12. To avoid installation errors, the wire organizer of the snap-in connector must be identified by the same standard color coding as the wires.

13. All CAT 6 (UTP) RJ45 connectors shall be fully compliant with the ISO/IEC 11801:2002 standard. The presentation of the outlet shall provide for labeling and identification.

14. A transparent window shall protect the labeling tag.

15. All outlets shall be equipped with shutters.

16. Snap-in Format (Where required): The dimensions of the Snap-in format connectors shall be H x W x D: 19.5 mm x 16.8 mm x 35.7 mm. The same format connectors (unscreened) shall be used on each link. The connector fits in specific structural hardware for Snap-in format of third parties. If not available, the Snap-in connector can be used in combination with a keystone clip and specific structural hardware for keystone connectors.

C. Faceplates: All faceplates installed, as part of this specification shall have these minimum features listed below:

1. Be applicable to both fiber and copper applications.

2. Be available in 2 and 4 port single-gang configurations.

3. Allow modules to be removed from the front of the faceplate.

4. Allow UTP modules to pass through faceplates even after termination.

5. Have write on designation labels for circuit identification together with a clear plastic cover.

6. Feature easily removable designation label covers which can be removed without use of tools.

7. Have as a minimum the standard colors of white, bright white, and alpine white.

8. Have optional modular furniture adapters available.

9. Have surface mount boxes single gang faceplates

10. Be manufactured using UV resistant, high impact thermoplastic to prevent color fading and provide additional durability.

D. Copper Patch Panels (RJ45):

1. Patch panels must have 19” equipment practice dimensions to permit mounting in standard cabinets, racks or bays.

2. Provide 24 ports Snap-in format (Modular) patch panels equipped with a cable management mechanism that provides strain relief, earthing and grounding features.

3. The presentation of the Patch Panel shall provide for labeling using a printed numbering system.

4. The connector shall provide both T568A and T568B colour code identification for the pins at the rear of the connector.

5. Patch panel outlets must have each Category 6 (UTP) RJ45 connector, connected separately.

6. The punch down is to be in accordance with the T568B color code. Reassignment of pairs is forbidden.

7. The screened connectors from modular patch panel shall provide termination facilities for the drain wire of each category 6A F/UTP cable.

8. All conductors from the 4 pair cable are to be terminated on the respective contacts. To avoid installation errors, IDC blocks must be identified by the same standard color coding as the wires.

9. Each patch panel shall provide a means to locate and clamp the incoming cables without causing damage to the cables or affecting the performance of link.

10. The installer must avoid any risk of cable pinching or compression during the installation of cable.

11. In the rack, the Patch Panels shall be separated by metallic patch-guides that have a closed front to protect the patch cords. The height of these guides will be 1U or 2U depending on the layout of the rack.

12. The metal frame of patch panel must not be earthed to the cabinet with a separate earth strap if the patch panels automatically make contact with the metal frame of the cabinets. If the cabinet is not designed to provide the panels with automatic earth, then the patch panels must be connected with separate earth strap to the earth key.

E. Intelligent Patch Panels:

1. Intelligent physical infrastructure management by providing a modular and scalable approach to meet the demands of enterprise and data center installations.

2. Standard copper and fiber cabling is used for all terminations onto the back of these panels while Patch Cords are used for cross-connect or interconnect installations.

4. Accommodates intelligent modules that mount in the rear and utilize no additional rack space zero RU.

5. Accepts all UTP, STP, and LC Fiber Optic Modules.

6. Accepts an Interface Unit to provide patch cord tracing and provisioning of switch ports with Interconnect Patch Cords or patch field mapping with Cross-Connect Patch Cords.

F. Patch Cords: To achieve a performance all Patch Cords will be Category 6 rated. All patch cord cable will be made from PVC or Low Smoke Zero Halogen (LSZH) material (when used in plenum areas).

1. Augmented category 6 component compliant out to 250MHz with operational bandwidth to 500MHz.

2. Factory assembled and 100% transmission tested with laboratory grade network analyzers for proper performance up to 500MHz.

3. Backwards compatible with lower performing categories.

4. Equipped with identical modular 8-position plugs on both ends, wired straight through with standards compliant wiring.

5. Have full 360° shield coverage and metal plug housing to provide durability and resistance to damage.

6. Have a PCB based plug to enable high levels of performance.

7. Have fixed position front contacts to ensure plug quality and consistent mating with outlets.

8. Have internal rear contacts to maintain cable pair symmetry to the point of termination.

9. Have a boot that features an ultra slim design for high density applications and snag free operation.

10. Use modular plugs.

11. Have a dual jack construction for excellent alien crosstalk performance.

12. Available in standard lengths of 3, 5, 7, 10, 15 and 20 ft. with custom lengths available upon request.

13. Have optional colored clips to allow field color coding even when cords are already installed. Available in Black, White, Red, Gray, Yellow, Blue, Green and Orange

G. Consolidation point/Zone Unit Enclosure: A zone unit is a termination connection point between open office cabling and horizontal cabling to allow for reconfiguration of the open office cabling. A zone unit is not a splice, it is considered to be a piece of connecting hardware. Installation guidelines are as follows:

1. No more than one zone unit may be used in a single horizontal cable run.

2. Each horizontal distribution cable exiting the zone unit shall have all pairs terminated in all eight positions of the modular outlets in the work area.

3. Cross-connections or active equipment shall not be permitted at a zone unit.

The zone unit shall have the following characteristics as minimum:

1. Enclosure designed to accommodate 24- or 48- work area modules.

2. Constructed of 16-gauge steel.

3. Feature 1.8” x 4.1” cable access entry points.

4. Incorporate ¼-turn hook and loop managers for routing of cables entering/exiting the enclosure.

5. Have two-piece, base and cover design.

6. Feature a low-profile design, which is 1.8", or lower in height.

H. Class E link or channel: Manufacturer should demonstrate guaranteed minimum worst-case performance to compliant with class E channel performance according to the ISO/IEC 11801: 2002 standard. Components used must be compliant with the category 6 standard mentioned above and the manufacturer should be able to demonstrate independent verification.

2.4 BACKBONE CABLING:

A. Data Backbone: This backbone will link the Switches located in the Floor Distributors (FD) to the Data network server through the Building Distributor (BD).

1. Optical Fiber Cable: The cable shall be suitable for connector manufacturer termination processes (LC, SC or ST connectors). Fiber splicing method should be used for termination of Fiber Cables using fiber pigtails manufactured by the same vendor.

Construction: Tight buffered with water blocking Aramid/Glass yarn reinforcements or tape and shall be suitable for indoor or outdoor use making it ideal for short campus links without the use of transition joints. The cable strength member shall be glass yarn laid longitudinally between the fibers and the inside wall of the outer jacket. The cable shall be dielectric construction, i.e. with no metallic content. The cable shall be a dry construction i.e. with no gel content. The jacket material shall be waterproof LSZH with a minimum fire performance of IEC 332 part 3C.

2. Single Mode Fiber Optic Cable

a. The Cabling system must be designed and installed according to ISO 11801 OS1 for indoor use, and ISO 11801 OS2 for outdoor use, compliant and should also meet EN50173 2nd editions and TIA/EIA 568B3. The Cable shall have 6 or 12 or 24 cores, 9.2/125 µm universal distribution cable with improved performance.

b. Low Smoke Zero Halogen - LSZH Jacket that does not give off toxic fumes in case of fire and offer flame propagation retardant properties.

c. Shall contain a Rip Cord applied longitudinally under the cable jacket for easy cable jacket removal.

d. Shall contain a lightweight Central Strength member located in the middle of the fibre bundles.

e. Shall contain both colour-coded buffered fibres as well as colour- coded buffer tubes.

f. Cables shall have length markings in 2 ft. increments.

g. Fibre will be available in strand counts of 4, 6, 12, 24, 36, 48, 72, 96, 144 and 288.

h. Shall meet these minimum performance parameters per standards specified above.

3. Optical Fiber Patch Panel:

a. Optical fiber Patch Panels shall be mounted in 19" frames of the cabinets. The patch panels shall be equipped with a mechanism that ensures the retention and support of incoming cables. An Earth Key shall be provided within the patch panel to earth any metallic part of the cable. The patch panel shall be designed with a sliding mechanism enabling front side installation and maintenance work to be carried out without having to remove the entire panel.

b. The patch panel shall provide facilities to recess the front connector plate deeper than the front of the 19" rails of the cabinet. This will provide sufficient bend radius for the patch cords once connected to the panel. This shall also prevent damage to the patch cords when the cabinet doors are closed.

c. Direct Termination of the connectors on to the fibers as well as splicing of pigtails shall be possible. The Patch Panel shall provide management for 1m of fiber per link after breaking the fibers out from the cable. The Patch Panel shall support the connector type specified for this installation. For multimode fiber links, these can be LC, SC and ST. The panel-mounted couplers shall be protected on the front presentation side of the patch Panel for safety purposes.

4. Optical Fiber Patch Cords

a. The Fiber adapters will be connected to the active equipment by means of duplex patch cords 2LC-2LC, 2 SC-2 SC or 2 ST-2ST as per client site standard.

b. The patch cords consist of 50/125 microns fibers and a LSHF-FR jacket. The SC or ST connectors shall comply with the International standard IEC 74-13. The patch cords should be available in lengths of 2 and 5 meters.

c. To avoid mix of patch cords built around different types of fiber, cords produced with LASER-optimized fiber will be used for both OM1 and OM2 optical fiber cables. When using OM3 optical fiber cables, patch cords produced with the same OM3 fiber have to be installed.

d. Fiber cables shall interface and connect to fiber interface unit at both ends as part of the fiber contractor work.

2.5 CABINETS:

A. The metal cabinets shall have a footprint of 800x1000 mm. In the frames 19” components can be mounted by means of the standard cage nuts. The front door consists of a metal framework with hinges and a central perforated panel. The side panels and the panel in the back have to be equipped with a hinge on the left or the right in order to facilitate the access to the equipment. A 42 U cabinet is preferred providing enough space for active equipment.

B. For an orderly cord storage and easy to manage installation, the following accessories shall be used:

- Closed 1 or 2 U patch guides between the patch panels;
- Lateral cable rings installed at both sides of the frames. The patch rings can be removed very easily by rotation and have to be located on the front rails of the 19" frames in the cabinets.

The cabinets should be supplied with:

- Provide power strip with 8 * 240VAC BS 1363 electrical sockets, No ON/OFF switch, 3-meter power cord and commando socket (male) at the end. Female commando outlet to be provided by the electrical contractor.
- Provide seismic kit, casters, leveling feet, and bolt down stabilization bracket for each cabinet.
- Provide Horizontal/Vertical Cable Management. 1 RU of cable management per 24 port patch panel and 1 RU above and below per 48 port patch panel.

C. Earthing has to be achieved .The cabinet and frame assembly when installed will also serve as equi-potential plane so that damaging external EMI currents can be drained off. To this end, the inter-cabinet connections shall also be made off by extending the earth connection from cabinet to cabinet in a suite of cabinets. The suite of cabinets shall be connected to the grounding network of the building.

D. The Earth key of the cabinet must be connected to the protective earth. The dimension of the earth conductor is 6mm². If no or only a poor protective earth system is present in the building, a separate earthing to the main earth terminal of the building is required. The dimensions of the conductor should then be 16mm².

PART 3 - EXECUTION

3.1 INSTALLATION:

A. The entire system shall be installed by specialist subcontractor approved by the Engineer.

B. Installation shall be in accordance with the approved drawings and manufacturer's written instructions.

C. System components and appurtenances shall be installed in accordance with ISO/IEC 11801, manufacturer's written instructions and as shown. Necessary interconnections, services, and adjustments required for a complete and operable signal distribution system shall be provided. Components shall be labeled in accordance with EIA/TIA 606. Penetrations in fire-rated construction shall be fire stopped. Conduits, outlets and raceways shall be installed in accordance with Section 16050 - BASIC ELECTRICAL MATERIALS AND METHODS. Wiring shall be installed in accordance with ISO/IEC 11801, EIA/TIA 568A and EIA/TIA 568B. Cables shall not be installed in the same cable tray, utility pole compartment, or floor trench compartment with ac power cables.

D. Horizontal Distribution Cable: The rated cable pulling tension shall not be exceeded. Cable shall not be stressed such that twisting, stretching or kinking occurs. Cable shall not be spliced. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items. Placement of cable parallel to power conductors shall be avoided, if possible; a minimum separation of 300 mm shall be maintained when such placement cannot be avoided. Cables shall be terminated; no cable shall contain unterminated elements. Minimum bending radius shall not be exceeded during installation or once installed. Cable ties shall not be excessively tightened such that the transmission characteristics of the cable are altered.

E. Riser and Backbone Cable: Vertical cable support intervals shall be per manufacturer's recommendations. Cable bend radius shall not be less than ten times the outside diameter of the cable during installation and once installed. Maximum tensile strength rating of the cable shall not be exceeded. Cable shall not be spliced.

F. Data Outlets: As a minimum each jack shall be labeled as to its function and a unique number to identify cable link. Minimum of 6 inches of slack cable loosely coiled into the data outlet boxes. Minimum manufacturers bend radius for each type of cable shall not be exceeded.

G. Unshielded Twisted Pair Patch Panels: Patch panels shall be mounted in equipment racks with sufficient modular jacks to accommodate the installed cable plant plus 10 percent spares. Cable guides shall be provided above, below and between each panel.

H. Fiber Optic Patch Panels: Patch Panels shall be mounted in equipment racks with sufficient ports to accommodate the installed cable plant plus 10 percent spares. A slack loop of fiber shall be provided within each panel. Loop shall be

900 mm in length. The outer jacket of each cable entering a patch panel shall be

secured to the panel to prevent movement of the fibers within the panel, using clamps or brackets specifically manufactured for that purpose.

I. For excavation and backfilling refer to Section 02200 - EARTHWORK.

3.2 ELECTRICAL SAFETY:

A. Separation of telecommunication circuits from the building electrical system and electrical equipment shall conform to the latest publications of Articles 800-3 (a) and 820-13 of National Electric Code (NEC) / per consultant's recommendations.

B. An earth or ground shall be provided and extended to the termination box and connected to each station protector. The earth or ground shall be installed and bonded in accordance with Article 250, 800 and 820 of National Electric Code (NEC)/ per consultant's recommendations.

3 TESTING (per consultant's recommendation):

A. General: After installation of entire system and prior to acceptance of work, manufacturer's standard tests shall be conducted in the presence of the Engineer to show proper operation of each equipment and the system entirely. The manufacturer of the cabling system shall provide copper (Data) and optical fiber testing procedures that clearly describes the tools and settings to be used to ensure correct measurements of the system. The result of testing shall meet or exceed the requirements of ISO/IEC 11801, latest edition and ISO/IEC TR 24750.

B. Testing of Class E: 100 % of the installed horizontal links shall be tested. The testing procedure has to comply with the standard ISO/IEC 11801: 2002 for Class E, according to the procedure for "Channel or Permanent Link". The measurements shall be done using Level III testing equipment. Channel testing shall be preferred. Channels shall be tested to support 10 G 500 MHz

The testers have to be calibrated according to the recommendations made by the supplier of the testing equipment. The following parameters have to be tested… Pair continuity (wiremap)

- Pair length
- DC Loop resistance per pair
- Insertion loss (Attenuation) per pair
- NEXT and Powersum NEXT for every pair combination
- FEXT and Powersum FEXT for every pair combination
- The ACR (ratio NEXT/ insertion loss) for every pair combination
- Return Loss (impedance match, retransmitted signal)

The complete test results of all the installed links or channels shall be collected in a certification file. It is preferred to have the test result in electronic format to facilitate the certification procedure. Apart from all the test results mentioned above, a few more documents shall be added to the file: a list of material used for the project, a design of the network, a Cable schedule per distributor and finally all the necessary co-ordinates of the persons responsible of the project.

C. Vertical Fiber Testing: The procedure shall comply with the ISO/IEC 14763-3 standard. The ISO/IEC 14763 standard specifies the implementation and operation of customer premises cabling. The part 3 of this ISO document (14763-

3) Details test procedures for optical fiber cabling designed in accordance with ISO/IEC 11801:2002 and installed according to the recommendations of ISO/IEC 14763-2 (Planning and installation of customer premises cabling).

For Multimode fibers, the test procedure is based on the use of the "one-jumper method" specified by Method 2 of IEC 61280-4-1. This procedure is used for testing links for which the connector loss is a significant portion of the total link attenuation. This is the case for LAN premises links.

For Single mode fibers, the test procedure to be applied is the same and is based on the use of the "one-jumper method" specified by Method 1a of IEC 61280-4-2.

Fiber-optic Tests applied to links and exclude equipment and work area cord.

OF Attenuation testing is used to verify the initial performance of the installed link. All 100 % of the installed OF links have to be tested and must pass the acceptance criteria.

The attenuation of the link is measured using the insertion loss method. This method uses an optical source and an optical power meter to compare the difference between two optical power levels.

When testing multimode optical fiber links with a Light Source and a Power Meter, this measurement kit has to be capable of operating at …

- 850nm and 1300nm for multimode fibers (OM1, OM2 & OM3)
- 1310nm and 1550nm for single mode fibers (OS1)

The test scenario with a Light Source and a Power Meter shall be one of the following for each link:

- Single direction @ 850nm and @ 1300nm for multimode fibers
- Single direction @ 1310nm and @ 1550nm for single mode fibers

The use of certification tool is recommended. Those tools are capable of producing a report logging the time of the test the link identification under test, the link length, the attenuation at the window tested and the acceptable link attenuation. The report shall also identify in which direction the testing was implemented.

When testing with basic optical source and power meter, the operator will fill up a report logging:

- The time of the test,
- The link identification under test,
- The link length and attenuation at the window tested.
- The report shall also identify in which direction the testing was implemented.
- Acceptable link attenuation (To be calculated)

The measured attenuation of the links shall have a lower value than the acceptable link attenuation calculated.

TECHNICAL SPECIFICATIONS

HVAC WORKS

1. GENERAL.

1.1 All equipment shall be of such overall dimensions, operating weights, service area requirements and configuration that it can be located where shown on the plans without any adverse effect on its performance and clearance requirements. Electrical input KW shall not exceed KW listed in Schedules. Any change in other trades work, anticipated by offering alternate equipment shall be estimated by the Contractor and its cost shall be included in the quoted price for HVAC works.

1.2 All equipment supplied under this section shall be brand-new, factory manufactured and factory assembled and complete in all respects. The type, characteristics, capacity rating, component sections of all equipment shall be as scheduled in the drawings.

1.3 All equipment furnished by the contractor shall include vibration isolation mounting, pads, anchors bolts frames or any other mounting or supporting accessories.

1.4 All power driven equipment shall include motor drives, motor foundation bases and accessories.

2. SHEET METAL DUCTING.

2.1 All sheet metal work for various air systems shall be furnished, installed, completely connected, tested and adjusted.

2.2 The Contractor shall make shop drawings of all duct work and the same shall included details of all splitters, takeoffs, vanes, dampers, elbows an all other necessary fittings required for the proper operation of the air system. Drawings and other details shall be submitted to the consultants for approval before fabrication.

2.3 Exact dimensions and locations of diffusers, registers and grilles shall be, submitted to the Consultants for approval, otherwise any changes directed after installation shall be made without additional cost. For diffusers and registers adequate provision shall be made in the neck connections for installation of deflectors and dampers.

2.4 All diffuser, register and grille necks/boxes must be tightly closed during construction to keep out rubbish.

2.5 All ducts passing through walls shall have 20 gauge G.I. sheet sleeves, extending 1/4”(6 mm) beyond the finished face of the wall both sides. The sleeves shall be of sufficient size to cover duct insulation or any other duct covering and allow at least 1/8”(3 mm) clearance in the sleeve for free movement of the ducting. The Contractor shall be responsible for supplying, locating and setting of all necessary duct sleeves.

2.6 All sheet metal ductwork shall be cut lengths coated by the Hot-Dip Method and manufactured per ISO standard 3575-76 Zinc Coating designation Z-275 and base metal quality.

2.7 All ducting shall be substantially built with approved joints and seams, shall be made smooth on the inside and neat on the outside. The duct joints shall be made as air-tight as possible. The laps shall be made in the direction of air flow and no flaking shall project inside the ducting.

2.8 Ducts, the width of the greater dimension of which exceeds 30 inches (750 mm), shall be constructed of not more than four feet sections. Ducts, the width of the greater dimension of which is less than 30 inches (750 mm), shall be constructed of not more than eight feet sections.

2.9 All elbows shall preferably be full radius type. If space does not permit, square elbows may be used with double thickness, shop fabricated, turning vanes reverted with the ducting. Due to space limitations curved elbows with less than a full radius bend may also be used provided single thickness turning vanes are installed in the elbow. Such short radius elbows of size up to 40”(1000 mm) - 60” (1500 mm) shall have one and over 60”(1500 mm) shall have two single curved turning vanes spaced around 3 inches (75 mm).

2.10 The supply and return air duct connections with the fans and equipment shall be made through heavy-duty air tight at least 8 oz. weight canvas flexible connection, at least 4”(100 mm) wide to prevent transmission of vibrations. The canvas collar shall be properly sewn and clamped at both ends.

2.11 The ducts shall be adequately supported from hangers firmly fixed and generally suspended from the building structure with the help of concrete inserts, bolts or shooting bolts. The hangers and supports shall not pierce the insulation, which shall be suitably protected and reinforced at that location. The bottom support shall be 1-1/4” x 1/4” M.S. flat or 1” x 1/8” angle for ducts upto 12” wide. 1-1/4” x 1/8” angle upto 30” width, 1-1/2”x 1/8” angle upto 72” width and 2” x 3/16” angle upto 96” width. Hangers shall be spaced on average at 10 feet centers with a hanger no further than 1 ft. on each side of any changes of direction. Ducting passing through building expansion joints shall be supported on either side of the joint. The hangers for horizontal ducts shall be 3/8” round rods for ducts upto 30” wide, 1/2” round rods or 1-1/2” x 1/8” M.S. flat upto 72” width and 1-1/2” x 3/16” M.S. flat upto 96” width. The vertical ducts shall be supported at each floor with M.S. angle or channel supports resting on the slab and bolted with the duct bracing of M.S. flat straps riveted with the duct. Perforated band or wire shall not be used in any circumstance for supporting ducts.

2.12 The ducting shall be fabricated according to the following schedule:

Rectangular Ducting

to 8” (200 mm) larger dimension	26 gauge
9” - 27”(225-675 mm)	24 “
28” - 51” (700-1275 mm)	22 “
52” - 81” (1300-2025 mm)	20 “
87” to above (2175 mm)	18 “

2.13 The ducts shall be fabricated with following type of joints or as approved:

(a) Longitudinal:

Pittsburgh lock, double seam, or grooved seam.

(b) Circumferential:

Duct larger dimension to 23”(575 mm)	Drive slip
24” - 42” (600 mm-750 mm)	1” (25 mm)high pocket lock or standing seam
43” - 72” (1075 mm-1800 mm)	1-1/2” high pocket lock standing seam.

2.14 The bracing for ducting shall be as follows:

Duct larger dimension	Size of bracing M.S. angle
To 23” (575 mm)	None
24” - 30” (600 mm-750 mm)	Joints at 4’ (1200 mm) centers without bracing or joints at 8’ (2400 mm)centers with 1” x 1” x 1/8”(300 x 300x3) bracing between joints.
31” - 42” (775 mm-1050mm)	1” x 1” x 1/8” (300 x 300 x 3) at 4’ (1200 mm) centers 43” - 72” (1075 mm-1800 mm) 1-1/2” x 1-1/2” x 1/8”(450 x 450 x 3) at 4’ (1200 mm)centers

Special joints, bracing and hangers, as specified by the Consultants, shall be used for ducts with larger dimension over 96” (2400 mm)

3. DUCT FLEXIBLE CONNECTION.

Flameproof flexible connections shall be furnished and installed on all suction and discharge connections of fans and air-conditioning units for presentation of transmission of vibration through the ducts to occupy spaces.

Flexible connections also be provided wherever ducts cross building expansion joints. Flexible connections shall be factory fabricated from Cotton Cloth as specified above or chemically impregnated

canvas if approved by the Employer/Consultant. Connections shall fit closely and are to be secured in an airtight fashion at connections to ductwork, fans and apparatus. The unclamped section of the flexible connection between apparatus and ductwork shall not be less than 150mm (6 in.) in length. Flexible connections shall not be painted or insulated. Samples of the material shall be presented to the Employer/Consultant for approval before installation.

4. AIR DAMPERS.

4.1 Furnish and install all dampers of the specified capacities and sizes as shown on the drawings, complete in all respects.

4.2 All dampers shall be of rigid construction, free of vibration, balanced, and control air volume properly.

4.3 Splitter dampers shall be fabricated of sheet metal, two gauges heavier than the duct gauge in which the damper is installed. The damper shall be fabricated of wood of an aerofoil shape, over which sheet metal shall be formed to completely cover the wood. The damper shall be operated by a 3/16 inch (5 mm) rod brought through the side of the duct with brass locking set-screw and bushing. The bushing shall be of thickness equal to the thickness of the duct insulation. The locking set screw shall be 1/4”(6 mm), arranged for easy locking of the damper operator at the desired position. The damper shall be installed with a full length hinge. Rubber gaskets shall be installed to minimize air leakage. The damper operator shall be galvanized and shall be designed for convenience of operation.

4.4 The quadrant volume damper shall be multi-leaf, opposed blade type, with a maximum blade width of 8 inches (200 mm). The damper shall be constructed of sheet metal, two gauges quadrant operators manufactured of brass. Operators shall be provided with standoff mountings on thermally insulated ducts to provide clearance between the duct surface and operator, equal to the thickness of the insulation. The quadrant operator shall be heavy duty, capable of being locked at desired position conveniently. Dampers, after fabrication, shall be provided with a baked enamel finish.

4.5 Duct test holes, with patches or threaded plugs in ducts and plenums, shall be provided, where directed or necessary, for using pitot tubes for taking air measurement to balance the air systems. At each of these locations where ducts or plenums are insulated, extensions shall be provided with plug fittings.

4.6 All dampers shall be of approved quality to meet the Consultant’s satisfaction.

5. AIR DEVICES.

5.1 Furnish where shown on drawings, all ceiling diffusers, all grilles, registers and louvers of sizes, capacities and types as specified.

5.2 The Contractor shall check and confirm with the air devices manufacturer that proposed diffusers, grilles and registers shall meet the capacity and “throw” requirements, without draught, dead spots and noise.

5.3 All air devices shall have a sponge rubber gasket around the perimeter for tight fit against adjoining structure.

5.4 Diffusers shall be round, square, rectangular or linear and furnished with multi-louver type volume dampers in neck controlled from face of the diffuser.

5.5 All wall type supply air grilles and registers shall have horizontal and vertical adjustable deflecting bars, and registers shall also have opposed blade volume control dampers, adjustable from the face with a removable key. Registers and grilles shall have a minimum of 75% free area.

5.6 All return grilles shall be of the fixed bar type to match supply out-lets and have a minimum of 75% free area. Return air registers, with opposed blade volume control dampers, adjustable from the face, one to be fixed where shown on the drawings.

5.7 All air devices shall be thoroughly cleaned, given anti-corrosion chemical treatment, one coat of acrylic melamine based baked primer and finished with anticorrosion and weather resistant acrylic-melamine plain or styrenated alkyd hammer baked enamel paint of approved color.

5.8 The fresh air intake and exhaust discharge louver shall be fixed where shown on drawings. These louvers shall be of fixed blades, angled to provide adequate weather protection and a free area of not less than 70%. They should be constructed, unless otherwise specified, of aluminum with vertical supports as necessary to ensure complete rigidity.

5.9 Registers and grilles on sidewalls shall be fixed on approved wooden frames. Perfect alignment and symmetry shall be maintained.

5.10 Unless otherwise specified, all grilles, registers, diffusers and louvers shall be of Aluminum, local manufacture of approved design and quality.

6. DUCT THERMAL INSULATION.

6.1 No insulation shall be applied to any ductwork, or to any surface, until all sections are sealed, tested & inspected by employer engineer, after words contractor has to ensure that all foreign matter has been removed from the surfaces to be insulated. All insulation shall be applied in a manner consistent with

good practice and methods. Before applying insulation the whole ductwork shall be pressure tested and perfectly sealed with silicon gum or with any other purpose made duct sealant, to be approved by the Engineer, around all the joints and possible leakage points.

6.2 The insulation shall be continuous through floors, walls, partitions, etc., except when otherwise indicated or specified. Where space will not permit application of insulation in wall or slab chase, the chase will be packed full of 85% magnesia mineral wool, asbestos rope, tape (multi layering), as approved by the Employer/Engineer.

6.3 Ducts shall be insulated with 3/8" (9mm) thick Built-in Microban with Green Guard certificate (anti-microbial & ant i fungal protection) Elastomeric Closed-Cell FM approved Foam type insulation having min. density 65 Kg/m3, thermal conductivity of 0.035 W/M at 0 Deg C and fire performance shall conform to UK building regulation i.e Class-0 rating with factory applied fire retardant type high density closely woven fiberglass cloth. Practical fire behavior of insulation should be self-extinguishing, non-drip and non-spreading flame type.

6.4 The weather exposed insulated ducting shall be insulated with ¾" (19mm) thick insulation of similar type as specified above in clause-25.3; further protected with fire retardant type high density closely woven shiny fiberglass cloth and finally covered with 26 gauge G.I. sheet cladding.

7. SOUND LINER.

Supply and install sound liner up to a length of 10 ft. from fan discharge / suction connections of each air-handler and at locations where specified. The liner shall be ¼" (6mm) thick fiber free, super silent and Microbe resistant synthetic rubber foam having density of 110 Kg/m3. The liner shall be capable of withstanding an air velocity of 4000 FPM. The liner shall adhere to all interior sides of duct with 75% coverage of fire retardant approved adhesive. Mechanical fastening on a maximum of 18% center in ducts exceeding 24" shall be provided.