



UNITED NATIONS HIGH COMMISSIONER FOR REFUGEES (UNHCR)

CONSTRUCTION OF PREFABRICATED COOPERATIVE MODEL (WEAVING CENTER) IN KHYBER PAKHTUNKHWA

TECHNICAL SPECIFICATIONS

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SECTIONS – 3000

STRUCTURAL STEEL WORKS

1.0 SCOPE

The work under this section consists of furnishing all material, labour, plant, equipment and appliances, fabricating, erecting, installing, testing, painting and all other items incidental to steel work for a complete job as shown on the drawings, specified herein and/or as directed by the Engineer.

2.0 APPLICABLE CODES AND STANDARDS

Latest edition of the following codes and standards are applicable to the work of this section:

AISC Specifications for the design, fabrication and erection of structural steel for buildings.

ANSI / AISC 360 Manual of steel construction, LRFD & ASD.

AISC 303 Code of Standard Practice, for Steel Buildings and Bridges.

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

AISC Guide to shop painting of Structural Steel.

ASTM A6 Standard specifications for general requirements for rolled steel plates, shapes, sheets, piling and bars for structural use.

ASTM A36 Standard Specifications for Carbon Structural Steel.

ASTM A53 Standard Specifications for Pipe, Steel, Black & Hot Dipped, Zinc Coated, Welded and Seamless

ASTM A307 Carbon steel externally and internally threaded standard fasteners.

ASTM A325 High strength bolts for structural steel joints including suitable nuts and plain hardened washers.

ASTM A446 Specifications for steel sheet zinc coated (galvanized) by the hot dipped process.

ASTM A490 Quenched and tempered alloy steel bolts for structural steel joints.

ASTM A501 Hot formed welded and seamless carbon steel structural tubing.

ANSI / NAAMM Metal Bar Grating
MBG 531

ASTM A563 Carbon and alloy steel nuts.

ASTM A572 Standard Specifications for High - Strength Low - Alloy Columbium – Vanadium Structural Steel

ASTM E109 Dry powder magnetic particle inspection.

AWS D1.1 Specifications for welding of steel structures.

ANSI
B 18.2.2.1 Plain Washers.

SSPC – SP6 Steel structures painting council – surface preparation specifications.

3.0 **MATERIALS**

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

3.1 **Structural Steel**

- Structural steel shall conform to the requirements of ASTM A-36, or ASTM A-572.
- Steel pipes shall conform to the requirements of ASTM A 53 Class B, ASTM A501 or shall be made of plates spirally welded.
- All material shall be supplied chirpy V-Notch testing in accordance with ASTM A6, Supplementary Requirement S5.
- Grating shall conform to ANSI / NAAMM MBG 531.

3.2 **Welding**

Welding electrodes shall match the base metal and shall conform to the requirements of AWS D1.1 specifications.

3.3 **High Strength Bolts**

All shop connections, except as noted herein or on the drawings, shall be made with High Strength Bolts in friction type connections, or by welding.

High strength bolts, heavy hexagonal nuts and hardened washers shall conform to the requirements of ASTM A325. All field connections, except noted, shall be made with high strength bolts in friction type connection.

3.4 **Washers**

Washers shall conform to the requirements of ANSI B18.2.2.1 and shall be of structural grade steel appropriate for the type of bolts for which they are used. For oversized holes, the washers shall be large enough to cover the entire hole by at least 6mm (1/4 in.) or as directed by the Engineer.

3.5 **Studies**

Steel Studies Shear Connectors shall conform to the requirements of Structural Welding Code-Steel, AWS D1.1.

4.0 **CONNECTIONS**

All connections shall be designed and detailed for 75% of the effective capacity of the member. A minimum of two bolts or equivalent welding shall be used per connection.

Shop connection may be welded or bolted. Field connections shall be bolted unless noted otherwise on design drawings or approved by the engineer.

5.0 ALLOWABLE STRESSES

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

6.0 SHOP DRAWINGS

- 6.1 Shop drawings shall be submitted by the Contractor, for structural steel works, for acceptance in accordance with the requirements or the Contract Documents.
- 6.2 Shop drawings furnished for this section shall conform to the best standards of the construction industry. Shop drawings shall be prepared by and under the supervision of competent engineering personnel. Prior to submittal, the Contractor shall check each shop drawing for compliance with the requirements of the Contract Documents.
- 6.3 Shop drawings shall include plans, elevations, sections and complete details to describe clearly, at an ample scale, all work to be provided. Drawings shall be accurately dimensioned and shall be noted clearly.
- 6.4 All connections shall be designed and detailed as, per sub-section 4 above, by the contractor on the shop drawings. Design calculations for connections shall be made as per AISC specifications and shall be submitted along with the shop drawings after checking and signing by the Contractor for approval of the Engineer.
- 6.5 The shop drawings shall include
- (i) An erection scheme, in suitable size, having the following information:
- Location of erection elements in respect of axis and Marks as well as picking points of these elements with respect to each other or with the existing steel or reinforced concrete structures.
 - Joints showing erection welding sizes and lengths, bolts diameter and numbers.
 - Chart showing list of assembling marks having columns such as Mark, Description, Quantity, Weight of each Mark, total weight and Remarks with grand total in the end.
 - Chart showing List of Erection Bolts, Nuts and Washers in tabulated form, detailing information such as size, quantity, weight and their grand totals.
 - Quality of materials.
 - Quality and type of welding electrodes.
 - Measures to be adopted against unscrewing of bolts.
 - Painting instructions.
 - Erection sequence.
 - References to relevant drawings.

- Except in special cases all scheme drawings shall be made in single fairly thick lines.
 - The recommended scale of erection scheme is 1:50, 1:100, 1:200, for joints 1:5, 1:10 or 1:20.
- (ii) Fabrication drawings in suitable size shall contain the following information:
- Each Shop Assembly (Mark) shall be drawn separately showing necessary lines, elevations, sections with reference to axis, center lines, location of holes, cleats, plates, lugs etc. fully dimensioned with part numbers.
 - Bolts and holes sizes.
 - Welding symbols and welded joints requirements, in accordance with AISC manual of steel construction and AWS specifications.
 - Geometrical Setting out dimensions necessary for the assembly of an element. Location and details of joints as calculated by the Contractor.
 - Instruction for welding, dimensions of weld, edge preparations methods of welding, and methods for control of distortions.
 - List of symbols for bolts and holes uses.
 - List of symbols for welds used.
 - Edge distance (general).
 - Welding sizes and lengths (general).
 - Standards and quality of materials.
 - Type and quality of welding electrodes.
 - Tests for welding.
 - Reference to related erection scheme drawings.
 - Reference to design and working drawings.
 - Part list.
 - Instructions for surface preparation, painting, primer and finish coats.

Recommended scales for fabrication drawings are preferably 1:10 or 1:20, and for joints and details 1:1, 1:2, or 1:5.

7.0 FABRICATION

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

7.1 Straightening of Material

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

7.2 Cutting

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

7.3 Holes Punching/Drilling

Holes shall be punched where thickness of the material is not greater than the diameter of bolt + 3mm (+ 1/8 in.). Where the thickness of the material is greater the holes shall either be drilled or sub-punched and reamed to size. The die for all sub-punched holes and the drill for all sub-drilled holes shall be at least 2mm smaller than the nominal diameter of the rivet or bolt.

7.4 Welding

7.4.1 All execution and inspection of welding shall be done in accordance with the provisions of the American Welding Society Specifications. No welding for piping/electrical supports shall be made transversely to any tension flanges or beams or columns.

7.4.2 Maximum and minimum size and lengths of fillet welds shall be in accordance with AISC specifications, or as mentions on drawing.

7.4.3 Surface to be welded shall be free from loose scale, slag, rust, grease, paint or any other foreign matter.

7.4.4 Butt welds shall be full penetration welds, unless otherwise specified and permitted.

7.4.5 Avoid the use of temporary welded attachments during fabrication as much as possible. After fabrication is completed, remove flush with the base material without encroaching on the minimum required base material thickness. After the surface has been restored, examine all areas from which temporary attachments have been removed by the same methods required for permanent fillet welds.

7.4.6 Do not begin structural welding until joint elements are tacked in intimate contact and adjusted to dimensions shown with allowance for any weld shrinkage that is expected. Weld heavy sections and those having a high degree of restraint with low hydrogen type electrodes. No member shall be spliced without approval.

7.4.7 For notch-toughness specified material, all weld metal, processes and preheat requirements shall be compatible to assure notch-tough composite weld metal.

7.4.8 Shop splices of webs and flanges in built-up girder shall be made before the webs and flanges are joined to each other.

7.5 Tolerances

Tolerances for Structural Steel be as per AISC Specifications unless noted otherwise.

8.0 WELDER QUALIFICATIONS

- 8.1 All welders contracted to perform work shall be required to show written evidence that they have been properly tested in compliance with the approved welding procedures.
- 8.2 Welders shall have been qualified in the proposed procedure by an established laboratory acceptable to the Engineer within the preceding 90 days.
- 8.3 All welders shall be qualified for the type of weldment, grade of steel, thickness of steel, welding process and welding position that they are employed to weld. Welders and welding operators that have not been performance qualified, for all material and thickness ranges used on the job, shall be restricted to welding only that portion of the work for which they are qualified.
- 8.4 Engineer reserves the right to have welders or welding operators requalified or removed from the job as he deems necessary during the progress of work. Engineer's decision regarding the qualifications of any welder shall be final.

9.0 WELDERS IDENTIFICATION

- 9.1 Each welder shall be assigned a unique identifying number or symbol that he shall use to identify all welding resulting from his skills.
- 9.2 Stenciled markings shall be applied within 40mm (1-5/8 in.) of the weld using low stress concentration dies. Written symbols are also acceptable.
- 9.3 A record shall be kept of these symbols by the Contractor. The records shall show welder's name, symbol assigned, procedures to which qualified, employment and test dates. This record shall be available to the Engineer's Representative at all times.

10.0 TEST ASSEMBLY

- 10.1 Fabricated components such as Beams Girders, Bracing, as and where required by planning, shall be test assembled in the shop prior to transportation to site.
- 10.2 Test assembly work and procedure should be planned during fabrication process.
- 10.3 Each test assembly shall be got inspected from the Engineer's Representative and shall be dismantled only after his approval in writing.

11.0 SURFACE PREPARATION AND PAINTING

Surface preparation and painting shall be in accordance with the provisions of the Code of Standard Practice of the American Institute of Steel Construction, Inc.

11.1 Surface Preparation

- a) All steel shall be cleaned free from loose scale, rust, burrs slag, etc. by means of sand blasting and/or other approved means as recommended by the manufacturer of paint.
- b) The sand used for this purpose shall conform to the type as specified in SSPC-SP.6. It should be free from earth, dust, clay and moisture. For this, the Contractor shall submit the gradation (no less than that passing through a 16 mesh screen U.S. sieve series) and source of sand along with the sample for approval by the Engineer prior to commencing the sand blasting operation.
- c) The size of sand particles, air pressure and size of the hose nozzle shall be correlated to give proper and acceptable surface.
- d) Material which is to be used for fabrication of components to be galvanized later on shall not be cleaned (See clause 11.3).

11.2 Painting

- a) After fabrication, assembly and surface preparation all assembled units shall be given two shop coats of epoxy primer and two coats of epoxy enamel paint in the fabrication shop.
- b) One final coat of epoxy enamel paint shall be applied after erection of all components.
- c) The thickness of each coat of paint shall be in accordance with the paint manufacturer's recommendation.
- d) All other requirements for the specified paint system shall be in accordance with the paint manufacturer's specifications/recommendations.
- e) The type of primer & paints to be applied shall be as specified in clause 11.2.1.
- f) The Contractor shall use the best quality of the type of paint specified and shall get the same approved by the Engineer.
- g) Steel work/Surfaces not to be painted
 - i) Steel work to be encased/embedded in concrete or surface in contact with concrete or grout shall not be painted, but shall be given a cement wash after surface preparation.
 - ii) Machined finished surfaces shall not be painted but shall be coated with rust preventive compound, approved by the Engineer immediately after finishing. Such surfaces shall also be protected with wooden pads or other suitable means for transportation. Unassembled pins, keys, and bolt thread shall be greased and wrapped with moisture resistant paper.
 - iii) Contact surfaces of connections using high strength bolts in friction type connections shall not be painted. Such surfaces of all components after fabrication shall be cleaned free of paint. No coating whatsoever then shall be applied to such surface. The surface roughness for high strength friction grip bolts is a

very important factor therefore components shall not be erected unless approved by the Engineer.

11.2.1 **Primer and Paint**

11.2.1.1 **Primer:**

Primer shall be epoxy primer of a proven quality. The type of primer to be used shall be approved by the Engineer.

11.2.1.2 **Paint:**

Paint shall be epoxy enamel of a proven quality. The type of paint to be used shall be approved by the Engineer.

11.3 **Galvanizing (Zinc Coating)**

Galvanizing, wherever specified, shall be applied in a manner and of a thickness and quality conforming to the requirements of ASTM A123 standard specifications for zinc (Hot galvanized) coating on products fabricated from rolled, pressed and forged steel shapes, plates, bars and strips.

Components shall be galvanized i.e. zinc coated after complete fabrication i.e. welding, drilling etc. the process shall consist of removal of rust and mill scale by pickling in hydrochloric acid or sulphuric acid followed by water wash and prefluxing in tanks containing zinc ammonium chloride and then fluxing with ammonium chloride. The fluxed components shall then be passed through a drying oven prior to immersion in a bath of virtually pure molten zinc.

12.0 **INSPECTION AND TESTS**

- 12.1 Manufacturer's Test Certificate for all material used shall be furnished by the Contractor for Engineer's scrutiny and approval.
- 12.2 Rolling tolerance of all shapes and profile according to AISC shall be in accordance with the provisions of ASTM A6 specifications. These shall be checked by the Contractor before commencing work and shall be rejected if found not within limits.
- 12.3 Materials shall be tested for conformance with the specified standards at an approved testing laboratory as and when directed by Engineer.
- 12.4 Contract surfaces of connections using high strength bolts in friction type connections shall be got inspected and approved from the Engineer before bolting.
- 12.5 All bolted connections shall be got inspected and approved from the Engineer for types, size, number of bolts and installation including tightening.
- 12.6 Inspection and Testing - Welding

12.6.1 **General**

Welding shall be inspected and tested by an approved testing laboratory during fabrication and erection of structural steel as follows:

The testing laboratory shall be responsible for conducting and interpreting the tests. It shall state in each report whether or not the test

specimens conform to all requirements of the Contract Document and shall specifically note any deviations therefrom.

Certify all welders and make 100 percent visual inspections and tests as follows:

- Record types and locations of all defects found in the welding work.
- The measures required and performed to correct such defects.

In addition to the requirements of AWS D 1.1, paragraph 8.15, each weld shall be visually free of slag, inclusions and porosity.

In addition to visual inspection of all welds magnetic particle, ultra-sonic and radiographic inspection shall be made of all welds as specified below. Magnetic particle tests shall be made on the root pass and finished weld.

The method of magnetic particle test shall be in accordance with ASTM E109. Any type of crack or zone of in-complete fusion or penetration shall not be acceptable.

Radiographic testing technique and standards of acceptance shall be in accordance with AWS D 1.1.

Ultra-sonic testing shall be performed in accordance with AWS D 1.1.

Welding inspection and test report showing evidence of the quality of welding shall be submitted by the Contractor. For each section of weld inspected and tested, furnish a report which clearly identifies the work, the welder's identification, the areas of inspections and test, the acceptability of the welds, and signature of the inspector or laboratory incharge. Each report shall be completed at the time of inspection or test. For radiographic examination, furnish a complete set of radiographs in addition to the reports. All inspection and testing shall be carried out in presence of the Engineer or his representative.

12.6.2 Test Methods

Use the following test methods as specified. The following list is in descending order. When a particular test method is specified for a joint and the method is impractical to use, use the next highest method practicable. The alternative method will be subject to approval, NDT procedures and techniques shall be in accordance with AWS D 1.1, section 6.7.

- a) Radiographic Method: In addition to the requirements of AWS D 1.1, comply with ASTM E94.
- b) Ultrasonic method.
- c) Magnetic particle method.
- d) Liquid Penetration Method: Visible-dye, solvent removable method only.

12.6.3 Members Designated for Tests

- a) Built – up Members:

Examine 100 percent of flange-to-flange and web-to-web welding by the radiographic method. For all web-to-flange and pipe column seam welding, examine ten percent of each welder's work as follows:

- Full penetration groove welds by the ultrasonic.
- fillet welds and partial penetration groove welds by the magnetic particle method.

b) Moment Connection Joints:

- Examine 100 percent of all flange-to-flange and web-to-web welding as follows:

Full penetration groove welds by the ultrasonic method or other method as designated by the Engineer.

Fillet welds and partial penetration groove welds by the magnetic particle method.

- For all web-to-flange welding, examine ten percent of each welder's work as follows:

Full penetration groove welds by the ultrasonic method or radiographic method as approved by the Engineer.

Fillet welds and partial penetration groove welds by the magnetic particle method.

c) Column Base Plates.

Examine 100% of all welding for connection of base plate to column.

d) Bracing Connections: Examine 100 percent of all welding for connection of diagonal bracing as follows:

- Groove welds by the ultrasonic method.
- Fillet welds by the magnetic particle method.

12.6.4 Requirement for ten percent Examination

- a) Examine a 300mm (12 in.) section of weld in each 3m (10 ft.) increment of each welder's work as directed by the Engineer. If the examination meets the acceptance standards of AWS D 1.1, the 3m (10 ft.) of weld represented will be accepted.
- b) if the examination fails to meet the acceptance standards, examine two additional 300mm (12 in.) sections in the 3m (10 ft.) increment as directed by the Engineer. If both of these examinations meet the acceptance standards, the 3m of weld represented will be accepted. Repair the defects detected in the first examination and re-examine.
- c) If one or both of the examinations fails to meet the acceptance standards, examine the remaining weld of the 3m (10 ft.) increment. Repair the areas that do not meet the acceptance standards and re-examine.

12.6.5 Repair and Re-Testing of Welds

Repair defective welds in accordance with AWS D 1.1, or replace the weld, and Re-test repaired and replaced welds by the same method and acceptance standard used to examine the original weld. In addition, when defective welds are found, the testing laboratory shall determine the cause of the defective welding and institute immediate corrective action.

All defective welding shall be repaired or replaced at the Contractor's expense.

12.7 Rejection

Neither the fact that the materials have been tested nor that the manufacturers test certificates have been furnished shall effect the liberty of the Engineer to reject material found not according to these specifications.

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

13.0 ERECTION

13.1 Bracing

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

Wherever piles of materials, erection equipment and other loads are carried during erection, proper provision shall be made by the Contractor to take care of the stresses resulting from such loads.

13.2 Alignment

No permanent bolting or welding shall be done at site during erection until as much of the structure as will be stiffened thereby has been properly aligned and approved by the Engineer.

13.3 Joints Using High Strength Bolts

All structural joints using high strength bolts shall be executed and inspected in accordance with "AISC Specification for structural joints using ASTM A325 or A490 bolts". High strength bolts and nuts, loosened after tightening, shall be discarded and replaced with unused bolts and nuts.

14.0 MEASUREMENT AND PAYMENT

14.1 General

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

14.1.1 Nuts, bolts, screws, washers, weld metal and welding rods.

14.1.2 Testing of materials and welds, and repair of defects.

14.1.3 Surface preparation including cleaning with sand blasting.

14.1.4 Painting system including primer coats.

14.1.5 Galvanizing

14.1.6 Fabrication

14.1.7 Erection

14.2 **Structural Steel Works**

14.2.1 Measurement

Measurement of acceptably completed works of structural steel will be made on the basis of weight in kilogram, according to approved shop drawings, after verification at site to the satisfaction of the Engineer that the items fabricated, supplied and erected in position conform with the contract and approved shop drawings.

14.2.2 Payment

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

14.3 **MS Railing**

14.3.1 Measurement

Measurement of acceptably completed works of MS railing will be made on the basis of actual length in running meter/ running foot, according to approved shop drawings, after verification at site to the satisfaction of the Engineer that the items fabricated, supplied and erected in position conform with the contract and approved shop drawings.

14.3.2 Payment

Payment will be made for acceptable measured quantity of MS railing works on the basis of unit rate per running meter / running foot quoted in the respective items of Bill of Quantities and shall constitute full compensation for all the works related to the item.

14.4 **Steel Door**

14.4.1 Measurement

Measurement of acceptably completed works of Steel door will be made on the basis of net actual area in square meter / square foot, according to approved shop drawings, after verification at site to the satisfaction of the Engineer that the items fabricated, supplied and erected in position conform with the contract and approved shop drawings.

14.4.2 Payment

Payment will be made for acceptable measured quantity of Steel door on the basis of unit rate per square meter / square foot quoted in the respective items of Bill of Quantities and shall constitute full compensation for all the works related to the item.

14.5 **Steel Grating**

14.5.1 Measurement

Measurement of acceptably completed works of Steel grating will be made on the basis of number of gratings, according to approved shop drawings, after verification at site to the satisfaction of the Engineer that the items fabricated, supplied and erected in position conform with the contract and approved shop drawings.

14.5.2 Payment

Payment will be made for acceptable measured quantity of Steel grating on the basis of number of gratings quoted in the respective items of Bill of Quantities and shall constitute full compensation for all the works related to the item.

14.6 **Steel Gate**

14.4.1 Measurement

Measurement of acceptably completed works of Steel Gate will be made on the basis of number of Gates, according to approved shop drawings, after verification at site to the satisfaction of the Engineer that the items fabricated, supplied and erected in position conform with the contract and approved shop drawings.

14.4.2 Payment

Payment will be made for acceptable measured quantity of Steel Gate on the basis of number of Gates quoted in the respective items of Bill of Quantities and shall constitute full compensation for all the works related to the item.

*** End of Section 3000 ***

SECTION - 4200

BRICK MASONRY

- 1. SCOPE**
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- 4. BRICK**
- 5. PLACING**
- 6. CURING AND REPAIR**
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- 8. TOLERANCES**
- 9. DAMP PROOF COURSE**
- 10. MEASUREMENT AND PAYMENT**

SECTION - 4200

BRICK MASONRY

1. SCOPE

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

2. MATERIALS

- 2.1 Portland cement for mortar shall conform to the applicable requirements specified in the section "Plain and Reinforced Concrete".
- 2.2 Sand for mortar shall be furnished by the Contractor and shall conform to the applicable requirements for sand specified in the section "Plain and Reinforced Concrete".
- 2.3 Water used in the manufacture of bricks and in the preparation of mortar shall be free from objectionable quantities of silt, organic matter, alkali, salts and other impurities, and will be tested and approved by the Engineer.
- 2.4 Bricks shall be the best available bricks in and around Islamabad/Rawalpindi District. In case satisfactory quality is not available the Engineer may ask for bricks from areas around Islamabad/Rawalpindi. Bricks/tiles for facing work shall be Fire bricks/tiles manufactured in accordance with relevant ASTM/BS standards.

3. MORTAR

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

Mortar for second class brick masonry shall be one part portland cement and six parts of mortar sand.

Mortar to be used in Fire bricks and tiles shall consist of one part cement, one part lime and four and half part sand blended with fine, grinded backed clay at 500 to 600 degree centigrade used for the manufacturing of fire bricks and colour pigment to match the colour of tiles and bricks.

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

4. BRICK

- 4.1 All bricks shall be of first class quality made from good brick earth, free from saline deposit and shall be hand moulded. They shall be thoroughly burnt without being vitrified, shall be regular, uniform in shape and size with sharp and square edges, parallel faces and of deep red or copper colour. First class bricks shall be homogeneous in texture and shall emit a clear ringing sound when struck, and shall be free from flaws, cracks, chips, stones and modules of lime. First class brick in an oven dried condition shall not absorb more than 1/5 of its weight of water when immersed one hour in water

at 21 to 27 degrees centigrade and shall show no signs of efflorescence on subsequent drying. The average compressive strength of five representative first class bricks shall be not less than 2000 psi and not less than 1700 psi for any individual brick.

- 4.2 All bricks shall be manufactured by the Trench Kiln Method or other standard methods approved by the Engineer. The earth used in manufacturing bricks shall be carefully selected and shall be free from objectionable quantities of lime, gravel coarse sand, roots, or other organic matter. Salts shall not exceed 0.3 percent and calcium carbonate shall not exceed 2.0 percent.
- 4.3 The moulds used in the manufacture of bricks shall be thoroughly sanded before each use and shall be sufficiently larger than the size of the bricks being manufactured to allow for shrinkage in drying and burning. Over-size, irregular and worn moulds shall be destroyed. Each finished brick for brick masonry shall be 9" by 4-1/2" by 3" in size and shall weigh between 7 lb. to 9 lb. All bricks shall have a "frog" 1/4" deep on one face.
- 4.4 Samples of first class bricks shall be submitted to the Engineer with test reports for his approval. Bricks of approved samples shall only be used in the works. If at any time, during the progress of the work, use of sub-standard material is found by the Engineer, such work shall be rejected and the Contractor shall replace the rejected work at his cost.
- 4.5 Samples of Fire bricks and tiles shall be submitted to the Engineer for approval. The Contractor shall ensure that only approved shade and size of tiles and bricks shall be used in the project.

5. PLACING

- 5.1 The methods and equipment used for transporting the bricks and mortar shall be such as will not damage the brick nor delay the use of mixed mortar. Brick shall not be placed during rains sufficiently heavy or prolonged to wash the mortar from the brick. Mortar already spread which becomes diluted by rain shall be removed and replaced before continuing with the work. All brick to be used in brick masonry shall be 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.
- 5.2 Bricks shall be laid "frog" upward with mortar joints and in English and Flemish bond as shown on the Drawings or as directed by the Engineer. Both bed and vertical joints shall be 3/8" in thickness completely filled with cement mortar as specified herein, and each brick shall be bedded by firmly tapping with the handle of the trowel. All horizontal joints shall be parallel and all vertical joints in alternate courses shall be directly over one another. Excess mortar at the outer edges shall be removed and joints drawn straight with the edge of a trowel and a straight edge. All anchors and similar work required to be embedded in the brick masonry shall be installed as the work progresses. At the completion of the work all holes or defective mortar joints shall be cut out and repainted.
- 5.3 The external face of Fire brick masonry and tile work shall be finished by deep struck pointing as the work proceeds. The joints shall be struck by the help of a pointing tool to provide a notch in the green mortar after the brick work has been laid. Horizontal joints shall be struck to form a weathered joint and vertical joints shall be struck with a V notch. Care shall be taken that the striking tools do not develop a cutting edge as the object of striking the joint is to compress the mortar into the joints. The curing of fire bricks and tiled surfaces shall begin after 36 hours of their laying.
- 5.5 Anchoing

All brick masonry shall be bonded to concrete columns/walls/beams with steel anchors as per details provided in drawing.

6. CURING AND REPAIR

- 6.1 All brick masonry shall be water cured and shall be kept wet for at least seven days by an approved method which will keep all surfaces to be cured continuously wet. Water used for curing shall meet the requirements of the Specifications for water used in the manufacture of bricks.
- 6.2 If, after the completion of any brick masonry work, the brick is not in alignment or level, or does not conform to the lines and levels shown on the Drawings, or shows a defective surface, it shall be removed and replaced by the Contractor at his expense unless the Engineer grants permission, in writing, to patch or replace the defective area.
- 6.3 Curing for Fire bricks and tiles shall start after 36 hours of their placement. The Contractor shall arrange his schedule in this regard to strictly ensure this requirement.

7. SCAFFOLDING

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

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

8. TOLERANCES

All brick work shall be erected plumb and true to line and level with maximum variation in any storey height or any length of wall being 1/8" in 10 feet. The maximum tolerance in the length, height or width of any single masonry unit shall be $\pm 1/8"$.

9. DAMP PROOF COURSE

All damp proof course unless otherwise specified shall consist of class 'C' cement concrete 2" thick, mixed with 5.5 lb 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, leveled and edges and corners made to the requirements of the relevant drawings including finishing and curing complete. All damp proof courses shall be laid over approved water proofing materials as specified on the Drawings.

10. MEASUREMENT AND PAYMENT

10.1 General

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

The rates quoted by the Contractor in the Bill of Quantities shall include work to be executed under these specification in any floor and at any height except where otherwise specifically stated in the relevant item of Bill of Quantities and the Contractor shall not be entitled to any claim or claim any compensation on this account.

10.1.1 Cutting & chiseling of masonry wherever required.

10.1.2 Cement sand mortar used in laying bricks including wastage.

10.1.3 Curing and repairing the masonry work.

- 10.1.4 All steel anchor bars/dovetail anchors etc. in masonry work.
- 10.1.5 Damp proof course of class 'C' concrete including water proofing agent.
- 10.1.6 Cutting and grinding of fire tiles/bricks where required with cutting machines
- 10.1.7 Cement, lime, sand, pigment and fine powdered clay mortar used in laying fire bricks and tiles including deep struck pointing and wastage.

10.2 Brick Masonry

10.2.1 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, the actual height shall be made good with 1:2:4 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 respective type of brick masonry will be made on the basis of number of cubic feet provided & installed in position as shown on the Drawing or as directed by the Engineer.

10.2.2 Payment

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

*** End of Section 4200 ***

SECTION - 6560

FALSE CEILING

- 1. SCOPE**
- 2. GENERAL**
- 3. MATERIALS**
- 4. SUBMITTALS**
- 5. PRODUCT DELIVERY, STORAGE AND HANDLING**
- 6. JOB SITE CONDITIONS**
- 7. INSTALLATION AND WORKMANSHIP**
- 8. FIXTURES**
- 9. FINISHING**
- 10. MEASUREMENT AND PAYMENT**

SECTION - 6560

FALSE CEILING

1.0 SCOPE

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

2.0 GENERAL

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

3.0 MATERIALS

3.1 Tiles

Tiles shall be of approved size, shape and colour as shown on drawing or as approved by the Engineer shall be used.

All four edges shall be revealed to be installed by an approved recessed suspension system, strictly in accordance with the approved shop drawings, manufacturer's recommendations or instructions of the Engineer.

3.2 Aluminum Panels

Aluminum panel ceiling (1 hour fire rated) shall be linear or flat, perforated or un-perforated with grooved joints and sound insulation, as specified, manufactured by DAMPA (Denmark), OWA or DAIKEN (Japan).

3.3 Hardwood Ceiling

This ceiling shall comprise of decorative geometrical patterned hardwood, gypsum plaster relief panels infill and stainless steel panels with cut mirrors and itched glass panels.

3.4 Suspension System

The suspension system for all types of false ceiling shall be in accordance with the recommendations of the approved false ceiling manufacturer and approved shop drawings, consisting of aluminum universal U-channels/ main T/Cross-T Bars, wall mouldings/ edge trims, hold down/adjustment clips, galvanized hanger strips with adjustment mechanism, etc.

4.0 SUBMITTALS

4.1 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.

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

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

5.0 PRODUCT DELIVERY, STORAGE AND HANDLING

- 5.1 Material shall be delivered in original, unopened, protective packaging, with manufacturer's labels indicating brand name, pattern, size, thickness and fire rating.
- 5.2 Material shall be stored in original protective packaging to prevent soiling, physical damage or wetting.
- 5.3 Cartons shall be stored in the installation area, opened at each end to stabilize moisture content and temperature, for 48 hours prior to installation.

6.0 JOB SITE 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.

7.0 INSTALLATION AND WORKMANSHIP

False ceiling suspension system and panels shall be installed in accordance with the requirements of BSI-CP.290 and with the manufacturer's recommendations as approved by the Engineer.

7.1 Suspension System

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

The framing of the specified section and run at spacing as per shop drawings. The jointing of runners to hangers shall be as per approved shop drawing details. The extra framing if required shall be provided for light receptacles as per approved shop drawing details.

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

7.2 False Ceiling tiles

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

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

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

8.0 FIXTURES

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

9.0 FINISHING

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

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

10.0 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.

- The rates quoted by the Contractor in the Bill of Quantities shall include work to be executed under these specification in any floor and at any height except where otherwise specifically stated in the relevant item of Bill of Quantities and the Contractor shall not be entitled to any claim or claim any compensation on this account.
- Aluminum approved suspension system including main channels, main tee/cross tee bars, wall moulding and edge trims, hanger strips and accessories, hold down clips, Aluminum tiles / strips etc. complete for aluminum tile / strips ceiling.

10.2 False Ceiling

10.2.1 Measurement

Measurement of acceptably completed works of respective types of false ceiling will be made on the basis of net actual area in square meter / square foot 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 respective type of false ceiling on the basis of unit rate per square meter / square foot quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

*** End of Section 6560 ***

SECTION - 6700

PAINING

1. **SCOPE**
2. **APPLICABLE STANDARDS**
3. **GENERAL**
4. **MATERIALS**
5. **DELIVERY, STORAGE AND CONTAINER SIZES**
6. **SURFACE PREPARATION**
7. **APPLICATION**
8. **JOB CONDITIONS**
9. **QUALITY ASSURANCE**
10. **SCHEDULE OF MEASUREMENT OF PAINT AREA**
11. **MEASUREMENT AND PAYMENT**

SECTION - 6700

PAINTING

1.0 SCOPE

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

2.0 APPLICABLE STANDARDS

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

2.1 BSI (British Standards Institution)

- 245 Specification for mineral solvents (white spirits and related hydrocarbon solvents) for paints and other purposes.
- 2521 Lead-based priming paint for wood work.
- 2523 Lead based priming paint for iron and steel.
- 2569 Sprayed metal coatings.
- 4800 Paint colours for building purposes.
- CP.231 Painting of building.
- CP.3012 Cleaning and preparation of metal surfaces.

3.0 GENERAL

- 3.1 Except as otherwise specified, all painting shall be applied in conformity with BS CP 231 "Painting of Building" as applicable to the work.
- 3.2 The Contractor shall repair at his own expense all damaged or defective areas of shop-painted metal work and structural steel work. Metal surfaces against which concrete is to be placed will be furnished shop-painted and shall be cleaned prior to being embedded in concrete.
- 3.3 Except as otherwise specified all concrete and plastered surfaces are to be painted.
- 3.4 The Engineer will furnish a schedule of colours for each area and surface. All colours shall be mixed in accordance with the manufacturer's instructions.
- 3.5 Colours of priming coat (and body coat) where specified, shall be lighter than those of finish coat. The Engineer shall have unlimited choice of colours.
- 3.6 Samples of all colours, and finishes shall be prepared in advance of requirement so as not to delay work and shall be submitted to the Engineer for approval before any work is commenced. Any work done without such approval shall be redone to the Engineer's satisfaction, without additional expense to the Employer. Samples of each type of paint shall be on separate 12" x 12" x 1/8" tempered hard board panels. Manufacturer's colour chart shall be submitted for colour specifications and selection.

4.0 **MATERIALS**

- 4.1 All materials shall be acceptable, proven, first grade products and shall meet or exceed the minimum standards of reputable manufacturers as approved by the Engineer.
- 4.2 Colours shall be pure, non-fading pigments, mildew-proof sun-proof, finely ground in approved medium. Colours used on-plaster and concrete surfaces shall be lime-proof. All materials shall be subject to the Engineer's approval.
- 4.3 All synthetic enamel paints and primers for structural steel works, metal work and wood works will be the best available of its type and shall be approved by the Engineer prior to its procurement.
- 4.4 Approved quality Weather Shield/Weather Coat paint shall be used for painting the exteriors of the structures or other surfaces where specified on the drawings as directed by the Engineer.
- 4.5 The plastic emulsion paint, vinyl emulsion paint or similar as approved by the Engineer shall be used for interior surfaces.
- 4.6 Texture coating wherever specified shall be acrylic resin based coating composed of acrylic copolymers, natural quartz, natural marble chips, metallic oxides, antibacterial and antifungal additives, and expanders, foaming and setting agents and shall be applied in accordance with approved manufacturer's recommendations.
- 4.7 Only paints manufactured by ICI, Berger, Nippon Paints or approved equivalent shall be used in this Project.
- 4.8 All material shall be delivered to site in their original unbroken containers or packages & bear the manufacturer's name, label, brand & formula & will be mixed and applied in accordance with his directions.

5.0 **DELIVERY STORAGE AND CONTAINER SIZES**

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

6.0 **SURFACE PREPARATION**

- 6.1 All oil, grease, dirt, dust, loose mill scale and any other foreign substance shall be removed from the surface to be painted, polished and white washed by the use of a solvent and clean wiping material. Following the solvent cleaning, the surfaces shall be cleaned by scrapping, chipping, blasting, wire brushing or other effective means as approved by the Engineer.
- 6.2 In the event the surfaces become otherwise contaminated in the interval between cleaning and painting, re-cleaning will be done by the Contractor at no additional cost.
- 6.3 Surfaces of stainless steel, aluminum, bronze, and machined surfaces adjacent to metal work being cleaned or painted shall be protected by effective masking or other suitable means, during the cleaning and painting operations.
- 6.4 All the surfaces to be painted with approved quality paint shall be free from dust, dirt, fungus, lichen, algae etc. Oil paint, varnish and lime wash should always be removed by scraping and washing.

- 6.5 All surfaces to be bitumen painted shall be thoroughly cleaned of any accretion, dust, dirt etc. by scraping, wire-brushing or as directed by the Engineer. The surface shall be primed with a coat of asphalt oil used at the rate of not less than 0.50 pound per square foot.

No work in this section shall be allowed until all surfaces or conditions have been inspected and approved by the Engineer.

7.0 APPLICATION

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

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

Effective means shall be adopted for removing all free oil and moisture from the air supply lines of the spraying equipment. Each coat of paint shall be allowed to dry or harden thoroughly before the succeeding coat is applied. Surfaces to be painted that will be inaccessible after installation shall be completely painted prior to installation.

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

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

- 7.2 Where shown on Drawings all exterior finishes shall be painted with Weather Shield/weather coat paint or acrylic based textured coating (graffito) as shown on drawings in approved colours as per manufacturer's specifications. The number of coats shall be as shown on the drawings or as directed by the Engineer.

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

8.0 JOB CONDITIONS

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

- 8.2 Place drop cloths to adequately protect all finished work.

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

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

9.0 **QUALITY ASSURANCE**

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

10.0 **SCHEDULE OF MEASUREMENT OF PAINT AREA:**

10.1 Irrespective of prime coats and number of paint coats applied to exposed painting surface area of column, walls, projections, ceilings, false 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.

11. **MEASUREMENT AND PAYMENT**

11.1 **General**

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

The rates quoted by the Contractor in the Bill of Quantities shall include work to be executed under these specification in any floor and at any height except where otherwise specifically stated in the relevant item of Bill of Quantities and the Contractor shall not be entitled to any claim or claim any compensation on this account.

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

11.1.2 Polishing works, including preparatory materials, scraping, cleaning, sanding etc.

11.1.3 Before application of paint on existing surface the old paint surface shall be removed existing paint, filling of cracks, surface preparation and application of primer coat, if any.

11.2 **Painting / Acrylic based textured Coating**

11.2.1 Measurement

Measurement of acceptably completed respective type of painting works / Acrylic based textured coating (graffito) will be made on the basis of net actual length in square meter / square foot of the surface painted / coated as shown on the Drawings or as directed by the Engineer.

11.2.2 Payment

Payment will be made for acceptable measured quantity of respective type of painting / acrylic based textured coating (graffito) on the basis of unit rate per square meter / square foot quoted in the respective items of Bill of Quantities and shall constitute full compensation for all the works related to the item.

*** End of Section 6700 ***

SECTION - 8001

GENERAL SPECIFICATIONS FOR ELECTRICAL WORKS

- 1.0 SCOPE OF WORK**
- 2.0 RULES & REGULATIONS**
- 3.0 AMBIENT CONDITIONS**
- 4.0 STANDARDS**
- 5.0 SYSTEM DATA**
- 6.0 EQUIPMENT**
- 7.0 DRAWINGS AND DATA TO BE FURNISHED BY THE CONTRACTOR**
- 8.0 MANUFACTURER'S INSTRUCTIONS**
- 9.0 GUARANTEE**
- 10.0 DANGER BOARDS WITH SIGNS, DESIGNATION AND SHOCK / FIRST AID CHARTS AND FIRE FIGHTING EQUIPMENT**
- 11.0 ASSOCIATED CIVIL WORKS**
- 12.0 INSTALLATION INSTRUCTIONS - GENERAL**
- 13.0 FACTORY TESTS**
- 14.0 TESTING - GENERAL**
- 15.0 APPENDICES TO BE FILLED IN BY THE BIDDER**
- 16.0 PAYMENT**

1.0 SCOPE OF WORK

The works related to the electrical system which is included in the Scope of this Contract as shown on the Drawings, stated in the Specifications and Bill of Quantities and explained in these Specifications. The works shall broadly include but not limited to the following:

- General Specifications for Electrical Works
- Low Voltage D.G. Set
- Indoor power Transformer
- H.T. Switchboards
- L.T Switchboards
- LT Distribution Boards
- Motor Control Centre
- Light Fixtures
- Low Tension Cables
- Wiring Accessories
- Conduits and Pipes
- Earthing
- Lightning Protection System
- Miscellaneous Items
- Structured Cabling Network
- Fire Alarm System
- Closed Circuit Television System
- Public Address System
- Cable Antenna TV System

The Contractor shall also be responsible to supply any other equipment not specifically mentioned in these Documents but which is necessary for proper operation of the works/system included in the scope of this Contract. The Contractor shall solely be responsible for ensuring proper functional requirements of different equipment. He shall also be responsible for furnishing any additional piece of equipment and for making modification in the equipment as desired and/or approved by the Engineer to achieve proper co-ordination with various equipment offered in the bid and also with those installed by others.

2.0 RULES & REGULATIONS

The entire electrical installation/work shall be carried out by licensed Contractor, authorised to undertake such work under the provisions of the Electricity Act 1910 and The Electricity Rules 1937 as adopted and modified upto date by the Government of Pakistan.

All works shall be carried out in accordance with the latest edition of the Regulations of the Electrical Equipment of Buildings issued by the Institute of Electrical Engineers-London, the Contract Documents, The Electricity Rules 1937 and bye-laws that are in force from time to time. Any discrepancy between these Specifications and any other rules and regulations shall be brought to the

notice of Engineer for his instructions and the discussion of the accepting/controlling shall be final and conclusive.

The Contractor shall be responsible for completing all formalities and submitting the test certificates as per prevailing rules and regulations, and shall have the installation passed by the Government Electric Inspector of that region. All requirements of the Electric Inspector and the WAPDA / MEPCO shall be complied with.

3.0 AMBIENT CONDITIONS

All material and equipment supplied and installed shall be designed, manufactured and tested to meet the following ambient conditions unless specifically stated otherwise for any material/ equipment.

Maximum indoors ambient temperature	:	45-Degree Celsius
Minimum indoors ambient temperature	:	Zero Degrees Celsius
Maximum outdoors-ambient temperature	:	50-Degree Celsius
Minimum outdoors-ambient temperature	:	Zero Degrees Celsius
Maximum Relative humidity	:	100 Percent
Maximum Altitude of project	:	220 meters above the mean sea level.

The atmospheric conditions are tropical and highly humid.

4.0 STANDARDS

The latest standards and codes of reputable organisations shall be applicable for the material and equipment specified herein and for installation work. Such organisations to be BSS, VDE, NFPA 99, NEC Article 517 etc. In case the Specifications laid down herein differ from those given in the standards, then the equivalent or better specifications shall govern. Wherever applicable the equipment shall also conform to the requirements of Pakistan Standard Institution (PSI).

Contractor shall maintain at the site office one copy of the standards / codes applicable to the works.

5.0 SYSTEM DATA

Unless otherwise specified elsewhere, all equipment and material shall be designed to operate satisfactorily with the following minimum requirements without any de-rating.

a) Voltage rating of equipment :	HT :	11 kV, 3 phase, +/- 10%
	LT :	400 V, 3 phase, +/- 10%
		230 V, 1 phase, +/- 10%

b) Frequency : 50Hz \pm 2Hz

In general, the electrical colour coding of switchgear cubicles, control panels, desks etc., shall be in accordance with the respective IEC Recommendations.

Live parts of electrical connections shall be colour coded according to IEC 446 as follows:

	Conductor Designation	Coding Alphanumeric	Colour
A.C. Network	Phase 1	L 1	red
	Phase 2	L 2	yellow
	Phase 3	L 3	blue
	Neutral	N	black
D.C. Network	Positive	L+	white
	Negative	L-	black
Earthing	Protective Earth	PE	green/yellow
	Earth	E	green/yellow

The colour coding for the secondary circuits of isolated power panel board is as follows:

Orange-Isolated Phase Conductor
Brown- Isolated Neutral Conductor
Green-Isolated Ground Conductor

Conductor insulation of secondary circuits of isolated power panel board shall be XLPE and PVC sheathed.

Control Cables

The Control Cables shall be manufactured according to specifications for L.T. Cables. The Control Cables shall be of multi-core, PVC insulated type withstanding without deterioration the conditions prevailing at the place of installation. The cross section of cable shall be as per the requirement of the system.

All the cores should be numbered and/or colour coded or otherwise properly identified. At-least 20% spare cores shall be provided in all Control Cables.

No separate payment is admissible for supplying, installing, testing and commissioning of control cables and is deemed to have been included in the BOQ rates of the respective equipment.

Distance in between power, communication and control cables shall be kept as per requirements laid down by NEC800, NFPA 70 and EN50174-2.

6.0 EQUIPMENT

6.1 IP Degree of Protection

The equipment shall have IP degree of protection as follows, unless mentioned other wise:

- IP 42 for indoor areas
- IP 54 for indoor damp areas
- IP 65 for outdoor areas

If properly rated equipment is not available, the Contractor shall provide field enclosures to attain the required IP degree of protection. If necessary cooling/exhaust fans and / or anti condensate heaters shall also be provided. No separate payment shall be made to attain the required IP degree of protection.

6.2 Identification & Labelling

All devices, meters, cabling, wiring and auxiliaries shall be properly labeled for identification. Labeling of equipment shall be done by means of flameproof material using indelible ink/markings. The labeling shall be such as to ensure uniformity and shall facilitate study of control diagrams/ drawings during operation and maintenance.

All labeling shall be of suitable size to be visible from the operating conditions/positions at site.

6.3 Lamp Test Facility

All equipment / switchboards, etc. shall be provided with common lamp test facility.

7.0 DRAWINGS AND DATA TO BE FURNISHED BY THE CONTRACTOR

The shop drawings, as-built drawings and/or technical data to be furnished by the Contractor for each electrical equipment, LT cable distribution layout & shall include, but not limited to the following:

- (a) Structural drawings showing foundations, RCC details dimensional plans,

elevation and sections on a suitable scale.

- (b) Electrical drawings showing:
- Line diagrams of Switchboards, Motor Control Centres, distribution boards and isolated power panels with detailed wiring diagrams, elevations/internal component layout and other standard details.
 - LT Cabling, Grounding/Earthing including all cable routing and support details.
 - Necessary execution details such as no. of cable/wires, size of conduits, cable routes, cable trays and cable trenches, etc.
 - Substation and Generator Room Equipment installation detail.
 - Manhole/Duct works.
- (c) Layouts of all LT cable routes with coordinates and levels.
- (d) Technical literature and manufacturer's characteristic data with the description of materials and weights of all equipment as instructed by the Engineer.

At least three (3) copies of the shop drawings and/or technical data of the equipment shall be submitted to the Engineer for checking and approval.

8.0 MANUFACTURER'S INSTRUCTIONS

The Contractor shall supply to the Engineer in properly bound form six (6) copies of manufacturer's instruction manuals for installation, testing, commissioning, operation and maintenance of the specified equipment including manuals of spare parts and tools of the equipment. At least two copies of the documents shall be submitted in original. The installation instructions shall be submitted 2 weeks prior to commencement of installation of each equipment, and operation and maintenance instruction at the time of commissioning. If the Contractor fails to provide the documents the Engineer shall withhold issuance of requisite certificates and deduct suitable amount from the payments to the Contractor.

9.0 GUARANTEE

The Contractor shall furnish written guarantee of the manufacturer or supplier with respect to satisfactory performance of each equipment. Guarantee shall be given for replacement and repair of part or whole of the equipment, which may be found defective in material or workmanship. The guarantee shall cover the duration of Maintenance Period as defined in the Conditions of Contract. This guarantee shall not relieve the Contractor of his obligations and he will be fully

responsible for the repair or replacement of any defective material in time, so as not to cause any undue delay in carrying out the repairs and/or replacements.

10.0 DANGER BOARDS WITH SIGNS, DESIGNATION AND SHOCK / FIRST AID CHARTS AND FIRE FIGHTING EQUIPMENT

Danger Boards having signs and designation of the room shall be installed on the external door of HT, LT, Power transformer, Low Voltage DG Set Rooms. Shock/First Aid Charts shall be installed in H.T, L.T and Low Voltage DG Set Rooms.

Potable fire fighting extinguisher suitable to control electrical fire shall be provided in H.T, L.T, Power Transformer and Low Voltage DG Set Rooms.

All the above items shall also be provided, wherever required to comply the requirements of the Pakistan Electricity Rules/Electric Inspector.

Laminated single line and adequate detail drawings on proper boards highlighting the main system features shall be displayed/ fixed in respective electrical and communication rooms.

11.0 ASSOCIATED CIVIL WORKS

Except where separately stated in the Bill of Quantities the cost of all civil works associated with any BOQ item of electrical works, such as excavation and back filling of earth, compaction of the earth, foundation pads, chiselling, making openings, etc. shall be included in the price quoted against respective items. No separate payment for such works will be made. Such works will also include repair of any damage to civil works caused by the Contractor during electrical installation.

12.0 INSTALLATION INSTRUCTIONS - GENERAL

The Contractor shall furnish all labour, materials, tools and equipment required to install, connect, test and commission all electrical equipment specified herein, whether or not such equipment is furnished by him or by others.

For all equipment to be installed by the Contractor, the Contractor shall supply and install all erection materials such as foundation bolts, washers, nuts, etc. as required and without any additional costs.

The Contractor shall set out the works himself as per Specifications and Drawings and shall properly position the equipment on specified foundation/location. In general, the manufacturer's instructions for installation shall be followed. Any defect or faulty operation of equipment due to the Contractor not following the manufacturer's instructions shall be corrected and repaired by the Contractor at his own cost.

For any deviation from the working drawings or specification that are deemed necessary by the Contractor due to site conditions, he shall submit the details and obtain the Engineer approval before starting such works.

13.0 FACTORY TESTS

All type and routine tests on Low Voltage D.G Set, Power Transformer, H.T Switchboards, LT Switchboards, Motor Control Centre, H.T Cables, LT Cables, and all other equipment shall be performed at the manufacturer's works in the presence of the Engineer or his Representative. Type tests may be waived off in case test certificates are submitted as certified by an Engineer approved standard laboratory of international repute; but merely producing the test type certificates will not relieve the manufacturer to carry out the required standard/routine tests.

The Contractor shall inform the Engineer about the date and time of test of each equipment at least two weeks in advance. This shall, however, be done after the Contractor has got the test procedures duly approved by the Engineer. The witnessing of test by the Engineer and the Employer shall not absolve the Contractor from his responsibility for the proper functioning of the equipment, and for furnishing the guarantees referred to in clause 9.0. All test results shall be supplied in quadruplicate. All expenses for carrying out the tests as incurred by the Engineer and the Employer to witness it shall be borne by the Contractor and deemed to have been included in the bid. Provision for at least two person's visit for Factory Acceptance Tests shall be made to include one representative each from the Employer and the Consultant/Engineer. The contractor shall undertake all formalities as may be required for the Engineer or his representative to enable him make the visit.

14.0 TESTING - GENERAL

14.1 Scope

Upon completion of the installation, the Contractor shall perform field tests on all equipment, materials and systems. All tests shall be conducted in the presence of the Engineer for the purpose of demonstrating equipment or system compliance with Specifications. The Contractor shall submit for Engineer's approval complete details of tests to be performed describing the procedure, test observations and expected results.

The Contractor shall furnish all tools, instruments, test equipment, materials, etc., and all qualified personnel required for the testing, setting and adjustment of all electrical equipment and material including putting the same into operation.

All tests shall be made with proper regard for the protection of the personnel and equipment and the Contractor shall be responsible for

adequate protection of all personnel and equipment during such tests. The cost of any damages or rectification work due to any accident during the tests shall be the sole responsibility of Contractor.

The Contractor shall record all test values of the tests made by him on all equipment. Four (4) copies of all test data and results certified by the Engineer shall be given to the Engineer for record purposes. These shall also include details of testing method, testing equipment, diagrams, etc.

The witnessing of any tests by the Engineer does not relieve the Contractor of his guarantees for materials, equipment and workmanship, or as any other obligations of Contract.

14.2 **Low Voltage D.G. Set**

Prior to the tests, the contractor shall submit manufacturer's recommended detailed description of the test procedures to be conducted for Engineer's approval.

The Contractor shall carry out full site load and no load tests in accordance with IEC, ISO or BS Specifications for site commissioning. The inspection and tests shall include but not be limited to:

Basic Tests:	Insulation Resistance Earth Continuity Earth Loop Impedance Polarity Phase Rotation Voltage and Frequency Starting System Protection Equipment
Battery:	Nominal Voltage Discharge Voltage Specific Gravity of Electrolyte Level of Electrolyte Charging System
Lubrication:	Check as required by manufacturer
Operational Check at Start-up	Oil Pressure Fuel Oil Leaks Operation of Safety Devices Operational Speed Automatic Control Instrument Check Exhaust Check Undue Vibration

Operational Check	Oil Pressure	
After one hour's run:	Oil Leaks	
	Cooling System	
	Oil Temperature	
Commissioning Test:	25% of full load	2 hrs.
	50% of full load	5 hrs.
	75% of full load	8 hrs.
	100% of full load	8 hrs.
	110% of full load	1 hr.

All commissioning and test results shall be recorded and compared with design data. A retest/commissioning shall take place if results are not satisfactory. All the tools, labour, POL, required for the testing and commissioning shall be provided by the Contractor at no extra cost. If required load is not available at site for testing the generators, the Contractor shall provide dummy load at site at no extra cost to the Employer. The correct functioning of the control equipment shall also be proved.

Battery Charger

Battery charger shall be static type and shall provide for both trickle and boost charging of the batteries when the engine is not in operation. The charger shall be of suitable capacity to fully recharge the completely discharged batteries within four hours at boost charge.

Control Panel

The Control Panel shall provide all the necessary control and monitoring devices of the Diesel Generating Sets. All the control and monitoring of the safety devices, alarms, protections, meters, lamps, etc. as mentioned in this Specifications and required as per good engineering practices for such an installation shall be provided in the Control Panel.

14.3 **Transformer Tests**

In addition to the insulation resistance test of the transformer, a polarity and phase rotation test shall also be made. Buchholz relay shall be tested for proper operation. Di-electric test shall be carried out on transformer oil prior to putting the same in operation.

14.4 **HT / LT Switchboards**

Each circuit breaker shall be operated electrically and mechanically. All interlocks and control circuits shall be checked for proper connections in accordance with the wiring diagrams given by the manufacturer.

The Contractor shall properly identify the phases of all switchgear and cables for connections to give proper phase sequence.

Trip circuits shall be checked for correct operation and rating of equipment served. The correct size and function of fuses, disconnect switches, number of interlocks, indicating lights, alarms and remote control devices shall be in accordance with approved manufacturer drawings. Nameplates shall be checked for proper designation of equipment served. Protective relays shall be tested and set at site prior to commissioning of the equipment.

14.5 Insulation Resistance Test

Insulation resistance test shall be made on all electrical equipment by using a meggar of 500 volts for circuits upto 250 volts and 1000 volt for circuits between 250 and 500 volts. For testing of 11 kV circuits, upto 5 kV meggar shall be used; the exact voltage shall be as advised by the equipment manufacturer unless otherwise advised by the Engineer.

The insulation resistance values of cables, transformer, switchgears, etc., shall be as per BSS, IEEE, NEC, ICEA and Pakistan Electricity Rules.

Before making connections at the ends of each cable run or joint between cables, the insulation resistance test of each cable section shall be made. H.T. cables shall be subjected to high voltage test as per recommendations of standard to which the cable is manufactured. Each conductor of a multi-core cable shall be tested individually with each of the other conductor of the group and also with earth. If insulation resistance test readings are found to be less than the specified minimum in any conductor, the entire cable shall be replaced and tests repeated on new cable. If cable joint is provided, then each cable section shall be tested, and joint made only after the tests have been made satisfactorily. Finally the completed cable length including the joints shall be tested.

The transformer and switchgears shall be given an insulation resistance measurement test after installation, but before any wiring is connected. Insulation tests shall be made between open contacts of circuit breakers, switches and between each phase and earth.

If the insulation resistance of the circuit under test is less than the specified value, the cause of the low reading shall be determined and removed. Corrective measures shall include dry-out procedure by means of heaters, if equipment is found to contain moisture. Where corrective measures are carried out, the insulation resistance readings shall be taken after the correction has been made and repeated twice at 12 hours interval. The maximum range for each reading in the three successive tests shall not exceed 20% of the average value. After all tests have been

made, the equipment shall be reconnected as required. Polarity test shall be made on single pole switching devices.

14.6 **Earth Resistance Test**

The Contractor shall make Earth resistance tests on the Earthing system, separating and reconnecting each earth connection.

If it is indicated that soil treatment or other corrective measures are required to lower the ground resistance values, the Engineer will determine the extent of such corrective measures.

The electrical resistance of the ECC together with the resistance of the Earthing leads measured from the connection with earth electrode to any other position in the complete installation shall not exceed one ohm.

Earth resistance test shall be performed as per Electrical Inspector's requirements. Where more than one earth electrodes are installed, the earth resistance test of each electrode shall be measured by means of resistance bridge instrument.

The complete lightning protection system shall be tested for continuity and earth resistance. The combined earth resistance at any point in the lightning protection system shall not exceed 10 ohms.

14.7 **Completed Tests**

After any equipment has been tested, checked for operation, etc., and is accepted by the Engineer the Contractor shall be responsible for the proper protection of that equipment so that subsequent testing of other equipment do not cause any damage to the already tested equipment.

14.8 **Expenses**

All expenses, i.e., travelling, boarding and lodging for carrying out the tests and witnessing by the Engineer shall be borne by the Contractor and are deemed to have been included in the BOQ rates of the respective equipment(s) by the Contractor.

14.9 **Spare Parts**

Contractor shall provide spare parts as identified in relevant appendix. The cost of each spare parts shall be carried over to relevant BOQ item and no extra payment shall be admissible in this regard.

14.10 Special Tools

Contractor shall provide special tools as indicated in Appendix-IV and as may be deemed essential for assembly, adjustment, dismantling, installation and maintenance reasons.

No separate payment shall be made for any special tools and cost shall be deemed to be included in the cost of the Contract.

15.0 APPENDICES TO BE FILLED IN BY THE BIDDER

The details regarding equipment manufacturers, deviations, etc., are to be furnished in the appendices attached with form of Bids, in accordance with the provisions of the clause "Requirements of Electrical Works" given in the instructions to Bidder, Volume - I.

16.0 PAYMENT

No separate payment shall be made for work involved within the scope of this section unless specifically stated in the Bill of Quantities or herein.

*** End of Section 8001 ***

ELECTRICAL WORKS

SECTION - 8111

LOW VOLTAGE D.G. SET

- 1.0 SCOPE OF WORK**
- 2.0 GENERAL**
- 3.0 APPLICABLE STANDARDS/CODES**
- 4.0 MATERIAL**
- 5.0 INSTALLATIONS & TESTING**
- 6.0 MEASUREMENT AND PAYMENT**

1.0 SCOPE OF WORK

The work under this section consists of supply, installation, testing and commissioning of all material and services of the complete Diesel generator set, Auto Main Failure (AMF) Panel and other equipment, as specified herein, shown on the Tender Drawings and given 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 location and position of the Diesel Generator Set, Auto-Main Failure (AMF) Panel, underground / above ground storage tanks and routing of cables.

The Diesel generator set, Instrument/Control Panel, auto main failure panel and accessories shall comply with the General Specifications for Electrical Works, Section-8001, and other relevant provisions of the Tender Document.

2.0 GENERAL

The Diesel generator set shall be a standard design of reputed manufacturer, who shall have similar units in operations for similar applications and field conditions. The manufacturer shall also have adequate maintenance facilities in the vicinity of Project with technically qualified and experienced personnel trained for operation and on-site maintenance of equipment offered by the Contractor in the tender bid.

The set shall be rated for continuous duty and suitable for indoor installation with protection rating IP23. It shall be capable for unbalance loads upto 30% of actual load and for continuous part load operation. The set shall be capable of starting and operation at the rated output at 0°C and at an altitude of 15 meters above mean sea level. The ratings must be substantiated with manufacturer's standard published data.

The Diesel Generator set shall, after reducing the power absorbed by the auxiliaries, deliver continuously rated power output under the site conditions. All auxiliaries, accessories and connections between systems along with all necessary cables, fittings, hardware, etc., for complete installation of Diesel Engine, Generator, Control / Instrument Panel, Auto-Main Failure (AMF) Panel, Duty Selection Switch, Fuel and Oil Storage, Batteries, Exhaust System, etc., shall be furnished by the Contractor.

The engine shall be directly coupled to the generator, and shall have a rated speed of 1500 rpm. The set shall be capable of sustaining without damage, 15% over speed under any abnormal operating condition.

The engine-generator set shall be mounted on suitable rigid steel frame skid with vibration isolators. Heavy duty lifting eyes and jacking screws shall be provided on the skid. The foundation bolts and all other material/hardware for complete installation of the set shall be furnished with the set. Any excessive torsional vibration shall be avoided for both engine and alternator.

The set shall be suitable for full load starting. When the generator is operating at no-load, the application of full load current, taking into account the surge due to starting of equipment, should be possible with maximum transient voltage drop of 15% of the rated voltage, and the time taken to restore the generator voltage to 97% of rated value should not exceed 1.5 seconds.

The set shall be capable for parallel operation.

The Contractor shall submit the equipment layout and other installation details as per manufacturer's recommendations for approval of the Engineer at least 60 days prior to the installation of the set.

Necessary provision, including connections and a Local / OFF / Remote control switch shall be made in the Generator Panel of each of the D.G. Set. The cost of such provision, connection, testing and commissioning are deemed to be included in the Cost of D.G. Sets and no separate payment shall be made against such works.

3.0 APPLICABLE STANDARDS/CODES

The Diesel engine and generator shall conform to the following standards as applicable.

- BS 5514 - Reciprocating Internal Combustion Engine.
- BS 4999 - General Requirements for Rotating Electrical Machines.
- BS 5000-99 - Rotating Electrical Machines of particular types or for Particular application.

For other equipment and materials related to the Diesel generator set, the Contractor shall follow relevant international standards, details of which shall be submitted to the Engineer for approval.

4.0 MATERIAL

4.1 Diesel Engine

The Diesel Engine shall be four strokes, compression ignition, suitable for continuous duty.

Starting shall be through electric starter motor operated on DC supply from lead acid batteries mounted on the skid. The batteries shall be furnished with the set.

The engine shall be equipped with an alternator type automatic charging system to charge the batteries during running of engine. A static battery charger installed in the control panel shall also be provided to charge the batteries when the engine is not running. Suitable interlocks shall be provided to prevent simultaneous operation of both charging systems.

The batteries shall be adequate to satisfy the following requirements:

- a. Crank the engine at firing speed for at least 15 seconds.
- b. If the engine does not start on the first attempt, crank the engine two more times for the above duration at an interval of 30 seconds between each cranking operation.
Engine shall be rated for continuous duty with overload capability for operating at least 10% above the rated capacity for 1 hour continuously in any 12 hours operation.

4.1.1 Air Intake

Air intake shall be through turbo charger and equipped with dry type filter. Suitable attenuators shall be installed to reduce noise at the air inlet.

4.1.2 Engine Lubrication

A gear type positive pressure lubrication pump shall be provided with efficient filtration arrangement for the lubrication system.

The heater shall be designed for automatic switching to ensure that temperature of oil is maintained for proper operation of the engine.

Engine shall have a constant oil level regulator, gravity fed from an engine mounted lube oil reservoir. Reservoir shall be equipped with an oil level gauge. Size of the reservoir should be suitable for 30 days continuous operation at full load.

A crankcase pressure release valve shall be provided to operate during excess pressure.

4.1.3 Engine Cooling

Engine shall have a forced air draft, water-cooled radiator supplied with a core guard. Cooling system shall have an engine driven centrifugal pump for cooling water circulation. Cooling shall be thermostatically controlled. An engine shut down timer shall be provided to keep the engine running on no-load after any operation of set, so that the engine is sufficiently cooled to start again instantly, if required, without rise in temperature above safe limits.

4.1.4 Exhaust System, Noise, Pollution

Exhaust system shall be equipped with a residential type silencer complete with muffler, exhaust manifold, flexible connector, exhaust elbow, exhaust pipe, rain cap, and associated fittings. The exhaust line shall be taken outside the building through the shortest possible and practical route, without any undue bends. This exhaust line shall be adequately covered with thermal insulation material over its entire length i.e. from the engine to the termination point. All supports for exhaust system shall be furnished.

The sound level in the diesel generator room shall not exceed the values of the noise rating curve NRC 95 to ISO TI 43-1961 standard, measured at 1 m distance from the object but in no case greater than 85 dB (A) under all operating conditions.

The exhaust fumes shall be burnt completely and be free of solid matters before escaping to the air.

4.1.5 Speed Governor

The speed governor shall be electronic type. Governor shall regulate engine speed so as to maintain the generator frequency within plus or minus 0.25% of the rated frequency. Stable engine speed shall be attained within 15 seconds after the engine has been started. Stable engine speed shall be restored within 10 seconds of any sudden change in load, from no load to full load. During this change of load or surge, the speed shall not vary by more than plus or minus 5% of the rated speed.

4.2 **Fuel System**

Engine of the generator shall operate on commercial high speed Diesel oil. A fuel oil strainer/filter shall be provided in the fuel line. Fuel system for Diesel engine shall be through explosion proof self-priming pump. The fuel system shall comprise:

- Underground fuel storage tank. (Common for all D.G. Sets)
- Fuel transfer pump(s).
- Fuel piping network. (Separate for each D.G. Set)
- Fuel day tank. (For each D.G. Set)

4.2.1 Underground Fuel Storage Tank

The underground outdoor fuel storage tank shall have the capacity as mentioned in BOQ item or shown on the drawings to store fuel for operation of the set at the rated output. The tank shall have high and low level float switches for monitoring the fuel level in the tank. The high and low level switches shall provide an annunciation while the low level switch shall in addition to above annunciation also prevent starting of set and to stop the set when the fuel in storage tank is at this level. The tank shall be provided with overflow, vent, supply and discharge valves, inspection cover, drain valve and glass sight gauge.

The fuel storage tank shall be of mild steel plates and shall be designed, fabricated and finished in accordance with the requirements of DIN 6608 - Horizontal Steel Tanks for underground storage of Petroleum Products in Liquid Form.

Underground fuel storage tank and supports shall be fabricated in accordance with the specified code and the following:

- Tank shall be capable to withstand maximum loads encountered during installation and operation for all conditions from empty tank to tank filled to capacity or overflow.
- Tanks shall be capable to withstand safely the forces and moments imposed by connecting piping.
- The buried tank shall be capable of sustaining lateral backfilling load of equivalent fluid pressure.
- The tank shall be capable of resisting flotation by providing concrete beams or saddles installed over the top of the tank or by hold-down straps bolted to a concrete foundation pad.
- The thickness of tank elements shall be increased over the thickness required by code requirements by 2mm for corrosion allowances.
- The tanks shall be provided with at least two lifting eyes.
- A nameplate shall be attached to manhole flange marked in accordance with the requirements of the code, and shall include following information:
 - Manufacturer's name/mark and year of fabrication,
 - Manufacturer's serial number,

- Design gauge pressure,
- Test gauge pressure,
- Design temperature,
- Applicable code stamp,
- Fluid stored,
- Storage capacity,
- Tank size.

Welding procedure qualifications, electrodes, preheat, post weld treatment, welder performance tests and submittals shall be in accordance with relevant international codes and standards.

Shell plate joints shall be butt welded with complete penetration and fusion. All joints in the attachments to the shell shall be fully seal welded to prevent rust staining.

Sharp welds and sharp corners shall be ground smooth and blended into the base material. All bottoms of the shell connections shall be flush with the inside of the shell unless otherwise indicated.

The interior surfaces of the tank shall be cleaned of all mill scale, cuttings, weld spatter and other foreign matter and shall receive a commercial sandblast in accordance with SSPC-SP 5.

All openings shall be sealed immediately after the last shell joint is made.

The exterior surfaces of all tank and piping shall be given a protective coating of the epoxy-phenolic-amine type.

All interconnecting steel pipes shall be seamless in accordance with ASTM-A 53 or approved equivalent. Pipe fittings shall be butt-welded type according with ASTM-A 53. All underground pipe and fittings shall be buried in accordance with ASTM D 1557. The pipe surface shall be given a protective coating of the epoxy-phenolic-amine type.

Welds shall be inspected in accordance with section VIII of the ASME Code, DIV-I.

Non-destructive examination procedures shall be submitted for approval before they are implemented.

Results of non-destructive inspection shall be submitted prior to installation as per requirement of section VIII, DIV-I of the ASME Code.

Tank shall be hydrostatically shop tested as required by ASME code, section VIII DIV-I, and shall be dried immediately after the test.

Before a hydrostatic test procedure is implemented it shall be submitted for approval, and shall include the recommended minimum and maximum hydro-test pressure with the corresponding minimum and maximum temperature.

4.2.2 Fuel Transfer Pumps

An explosion proof electric self-priming, fuel pump of suitable capacity to fill the fuel day tank from the outdoor underground fuel storage tank in 30 minutes or lesser time shall be provided. A manual fuel pump shall also be furnished and connected in parallel to the electric fuel pump, with a capacity to fill the tank in 2 hours maximum. All interconnected piping, valves, etc., for parallel connection of the two pumps shall be furnished. The electric starter, circuit breaker, wiring, etc., for the electric pump shall be provided alongwith the Fuel Storage Tank by the Contractor without any extra cost.

4.2.3 Fuel Piping Network

The fuel piping network separate for each D.G. Set to be furnished shall include fuel supply pipe from storage tank to day tank in the skid of the D.G. set, over flow pipe from the tank to the set, drain pipe from the tank to a location approved by the Engineer.

The arrangement of pipe work with respect to the location of equipment shall be prepared by the Contractor and submitted to Engineer for approval. A full flow oil filter shall be installed in the fuel supply lines with a by-pass arrangement.

4.2.4 Fuel Day Tank

The engine generator skid mounted fuel day tank for each D.G. Set shall have capacity to store fuel for 8 hours operation of the set at the rated output. The tank shall have level switch for monitoring low fuel level in the tank. The low level switch shall provide an annunciation and prevent starting of set and to stop the set when the fuel in storage tank is at this level. The tank shall be provided with overflow, vent, supply and discharge valves, inspection cover, drain valve and glass sight gauge.

4.3 **Generator**

Generator shall be synchronous. The generator shall be capable of carrying continuously for 1 hour in every 12 hours, overload equal to 10% of rated output with field set for normal rated load excitation.

4.3.1 Excitation

Excitation shall be from brushless rotating diodes mounted on the main shaft for 3-phase full wave rectification.

4.3.2 Windings

Alternator windings shall have Class-F insulation and shall be impregnated for tropical use. The temperature rise of winding under normal operating conditions and at rated load shall not exceed the limits specified for Class-B insulation. Anti-condensate heaters shall be provided for windings. The heaters shall be thermostatically controlled for switching ON after the set has stopped. The thermostat range shall be adjustable and set to prevent overheating of windings. For protection of windings from damage due to overheating, thermistors shall be embedded to stop the set in case the temperature of winding rises above the safe value.

4.3.3 Voltage Regulation

Voltage regulator shall be solid state with provision for manual setting. Regulator shall be so designed to protect the exciter when the set is running at reduced speed during starting or idling of the prime mover.

Voltage regulation shall be plus or minus 0.25% from no-load to full load. Transient voltage drop shall be less than 15% at full load and 0.8 power factor. Time required to restore to steady state conditions after transient voltage fluctuation shall not exceed 10 seconds.

4.3.4 Short Circuit Capability

Generator shall be capable of withstanding without injury, a 30 seconds three-phase short circuit at its terminal when operating at rated output and power factor with fixed excitation.

4.3.5 Deviation Factor

The deviation factor of the open-circuit line-to-line terminal voltage shall not exceed 0.1

4.4 Control / Instrument Panels

The Control / Instrument Panel for each generator shall be designed for front access, completely assembled, wired and tested. The control panel shall conform to the constructional requirements as stated in these specifications for Switchboards. The panel shall comprise but not limited to the following main components.

4.4.1 Generator Panel

This shall incorporate protection and control equipment, measuring instruments, control and instrument transformers, voltage regulator, governor controls, battery charger, indicating lamps, etc.

4.4.1.2 Instruments

- i) Ammeter with selector switch.
- ii) Voltmeter with selector switch.
- iii) Frequency meter.
- iv) Kilowatt-meter.
- v) Local / OFF / Remote Control Switch.

4.4.2 Engine Panel

An instrument panel on the skid shall have calibrated gauges/meters to measure the following:

- i) Engine speed.
- ii) Lube oil pressure.
- iii) Lube oil temperature.
- iv) Engine running hours

4.4.3 Safety Devices

Following safety devices shall be provided. The audible alarm shall operate on any fault condition and shall be resettable manually and automatically through a timer after 15 minutes whichever is earlier:

A = Alarm SD = Shutdown TD = Adjustable Time Delay

- | | | |
|------|------------------------|--------------------|
| i) | Engine Over speed | A SD |
| ii) | Low lube oil pressure | A SD |
| iii) | High water temperature | A SD |
| iv) | Over voltage | A SD (TD=0-30 Sec) |

v)	Under voltage	A -
vi)	Low level in fuel day tank	A SD (TD=0-5 min.)
vii)	High level in fuel day tank	A -
viii)	Charger failure	A -
ix)	Over crank	A SD
x)	Low crankcase oil level	A -
xi)	High crankcase oil level	A -
xii)	Charging alternator failure	A -

After shut down, the set shall lockout and it shall not be possible to start it unless manually reset after the cause of fault has been removed.

4.4.3 Batteries & Battery Charger

The batteries provided with each D.G. Set shall be of sufficient capacity to perform all required functions; including the operation and control of AMF Panel and Automatic Transformer Switch (ATS).

Battery charger shall be static type and shall provide for both trickle and boost charging of the batteries when the engine is not in operation. The charger shall be of suitable capacity to fully recharge the completely discharged batteries within four hours at boost charge.

4.4.5 Lamp Test Facility

A common lamp test facility shall be provided for each control panel/instrument panel.

4.5 **Automatic Transfer Switch (ATS)**

The Automatic Transfer Switch shall be 4 pole and rated for cumulative capacity of the two generators. ATS shall employ two numbers motorized Air Circuit Breakers to feed the load from the main supply or generators.

5.0 INSTALLATIONS & TESTING

The Diesel generator set and associated equipment with accessories shall be installed at location shown on the drawing. The Contractor shall ensure co-ordination with the civil works for providing any openings, holes, etc. to avoid any breakage to completed works. In case the provisions in civil works for installation of electrical equipment are not made or made incorrect the same shall be rectified by the Contractor at his own cost and to the satisfaction of Engineer. The Contractor shall provide foundation bolts and grout them in cement concrete floor using non-shrinkable material with the approval of Engineer.

All installation materials for physically installing the Diesel generator set and associated equipment, such as bolts, nuts, washers, supporting steel, etc., shall be provided and installed by the Contractor. The generator shall be installed upright and in level and shall be firmly and rigidly bolted to the steel frame skid with vibration isolators.

The Diesel generator set shall be completely erected as per manufacturer's instructions and as approved by the Engineer. Loose parts dispatched by the manufacturer shall be installed and connected as per assembly drawing provided by the manufacturer. Any safety locking of meter, relays, etc., provided by the manufacturer for safe transport shall be released only after the generator/ control panel is erected in position.

The incoming and outgoing cables shall be connected as recommended by cable manufacturer. The cable armour shall be connected effectively to ground.

The Diesel generator and associated equipment body shall be connected to earth as per instructions given in section "Earthing" of these Specifications. The Diesel generator set shall be tested and commissioned in the presence of the Engineer. The tests to be carried out are described in article "Testing" of General Specifications for Electrical Works, Section-8001 of these Specifications.

The tank shall be installed in accordance with best engineering practice/international codes, the approved shop drawings, applicable code requirements and manufacturer's instructions.

6.0 MEASUREMENT AND PAYMENT

6.1 General

The Contractor's bid amount against each item of Bill of Quantities as given below shall include supply, installation, testing, commissioning and completion for all work specified herein and/or as shown on the Tender Drawing/B.O.Q. related to the item.

6.2 Diesel Generator Set

6.2.1 Measurement

Measurement shall be made for each Diesel Generator Set including Fuel Day Tank, Control/Instrument Panel, Gravity Louvers, and Control Wiring to Control/Instrument Panel of other generator, AMF Panel, L.T switchboard etc. acceptably supplied and installed by the Contractor as a complete job.

6.2.2 Payment

Payment shall be made for the number of jobs measured as provided above at the Contract unit price each for supply, installation, testing, commissioning and completion of the Diesel Generator Set, including its reinforced concrete foundation, Fuel Day Tank, Gravity Louvers matching with radiator, Control / Instrument Panels and accessories, control wiring between D.G. set and Control/Instrument Panel, AMF Panel, L.T switchboard fixing arrangements, all testing arrangements, etc.

6.3 Fuel System

6.3.1 Measurement:

Measurement shall be made for Fuel System comprising underground Fuel Storage Tank of capacity mentioned in BOQ/drawings including pumps all accessories and piping acceptably supplied and installed by the Contractor as a complete Job.

6.3.2 Payment

Payment shall be made for the number of jobs measured, as provided above at the Contract unit price each and shall constitute full compensation for supply, installation, testing and commissioning of underground fuel storage tank with excavation, backfilling, sand filling, reinforced concrete foundation/structure (including reinforcement) and fixing / supporting structure and all other accessories complete with all type of valves, fuel transfer pumps (both electric and manual) float switches control / power wiring, control panel for automatic operation of the pumps, for each generator fuel piping network with required filters for each generator as per Specifications and required for normal operation of both D.G. set.

6.4 **Spare Parts**

6.4.1 Measurement

Measurement shall be made for the spare parts of Diesel generator set as listed in form of Tender Volume-I, acceptably supplied by the Contractor as a complete lot.

6.5.2 Payment

Payment will be made for the complete job of spare parts as provided above at the Contract unit price and shall constitute full compensation for supply, tagging, and packing of spare parts including wooden/steel storage boxes as required.

*** End of Section 8111 ***

SECTION - 8133

LT DISTRIBUTION BOARDS

- 1.0 SCOPE OF WORK**
- 2.0 GENERAL**
- 3.0 APPLICABLE STANDARDS/CODES**
- 4.0 MATERIAL**
- 5.0 INSTALLATIONS**
- 6.0 MEASUREMENT AND PAYMENT**

1.0 SCOPE OF WORK

The work under this section consists of supplying, installing, testing, and commissioning of all material and services of the complete Low Tension (LT) Distribution Boards as specified herein and/or shown on the Bidding Drawings and stated in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and coordinate at site with other services for exact location and position of the each L.T. Distribution Board.

The Low Tension Distribution Board with accessories shall also comply with the General Specifications for Electrical Works, Section - 8001 and with other relevant provisions of the Bidding Document.

2.0 GENERAL

The Low Tension Distribution Board (DB) shall be sheet steel fabricated suitable for surface/recessed mounting on wall or floor standing totally enclosed, dust tight and vermin proof. It shall be complete in all respect with material and accessories, factory assembled, type-tested and finished according to the Specifications and to the normal requirements. The LT Distribution Board shall have protection class IP-42 for indoor installation, class IP-54 for indoor damp areas and class IP-65 for outdoor area.

The minimum form of construction to be followed for type tested DBs is as follows:

	Equipment Type	Min IP Rating	Min Form of Construction
1	Main LT Panel (MLTP)	IP 54	Form 4b, Type 6
2	Distribution Boards below 250A	IP 41	Form 2b, Type 2
3	Sub Main Distribution Boards above 250A	IP 41	Form 3b, Type 2
4	Final Circuit Distribution Boards	IP 41	
5	Life Safety/Emergency Distribution Equipment	IP 54	Form 4b, Type 6

The Low Tension Distribution Board shall be front operation type and shall:

- have a rated service short circuit breaking capacity (Ics), conforming to IEC 60947-2 and as shown on the drawings.
- be provided with adequate clearance from live parts so that the flashovers can not be caused by switching, vermin, pests etc.
- be suitable for 400 Volts, 3 phase 4 wire, 50 Hz system.
- be designed for flush mounting of all instruments on the front side.

- have incoming and outgoing cable termination arrangement, terminal block/line up terminals.
- be provided with stainless steel name plate on the front side of door.
- have all incoming and outgoing connections from top or bottom as per requirement of site conditions.
- have door grounded by flexible copper strip/cable.
- have wiring diagram in the pocket inside the door of Distribution Board

3.0 APPLICABLE STANDARDS/CODES

The latest editions of the following standards and codes shall be applicable for the materials specified within the scope for this section:

- IEC 60051 - Direct setting electrical measuring instruments
- IEC 60073 - Colours for indicator lights and push buttons
- IEC 60947-2 - Low voltage switchgear and control gear
- IEC 60439 - Low Voltage Switchgear and Control gear Assemblies.
- BS 4752 - Circuit Breaker
- BS 3871 - Miniature & Moulded Case Circuit Breakers
- BS 88 - HRC fuses
- BS 89/90 - Ammeters and Voltmeters
- BS 3938 - Low voltage current transformers
- BS 1432 - Bus Bars

4.0 MATERIAL

4.1 Sheet Metal Work

The Low Tension Distribution Board (DB) shall be fabricated with 16 SWG/14SWG sheet steel recess / surface mounting as approved by the Engineer. All the components shall be installed on a common component mounting plate inside the enclosure and protected from the front with screwed sheet steel front plate. The enclosure shall be

provided with rubber gasketing and a lockable hinged door with cam fastener.

The distribution board shall be supplied complete with all installation materials as recommended by the manufacturer. The incoming and outgoing cable connections shall be according to the wiring requirements. If required, an adapter box for accommodating the cables and conduits may be provided. The box shall be of the same material and finish as the DB. All holes, cutout etc. shall be tool and free from burrs and rough edges.

The cabling inside the DB shall be suitably harnessed by means of straps or cords. Colour sleeves shall be provided on each cable lugs connected to the bus bars, circuit breakers or terminals for phase identification. An earth bar shall be provided for connection of incoming and outgoing earth conductors. The earth bar shall be permanently connected to the body of DB at two points. Flexible copper strip shall be provided for earthing of the door of DB.

Circuit numbers/ designation on all circuits shall be conspicuously marked to facilitate connection and maintenance.

All metal work of the DB shall be cleaned down to bare shining metal phosphated and the surfaces chemically prepared for powder coating. Then these shall be coated with powder of colour RAL 7032 and then baked in oven. The thickness of powder coating shall not be less than 120 microns.

4.2 **Components**

The Low Tension Distribution Boards (DB) shall be provided with components as specified, as shown on the Bidding Drawings and required for the satisfactory operation of the distribution board and of the electrical system.

Typical component specifications are given below:

4.2.1 Bus Bars

The Bus bars shall be made of 99.99% pure high conductivity electrolytic tinned copper and shall be completely isolated and mechanically braced for the specified fault level. The identification of bus bars shall be by providing colours sleeves on bus bar ends and these shall be red, yellow and blue for phases and black for neutral. The earth bus bar shall be green.

The bus bars shall be for three phase, neutral and earth and shall be of appropriate size to meet the electrical and mechanical

requirements of the system. The temperature rise shall not exceed 30°C at rated current.

4.2.2 Moulded Case Circuit Breaker (MCCB)

The MCCBs shall be moulded case triple pole 440 Volts or single/double pole 250 Volts of current ratings as shown on the drawings. These shall have fixed magnetic short circuit and adjustable/fixed thermal overload protection.

Under voltage and shunt trip etc. shall also be provided when so required for safe operation and interlock.

The MCCBs shall be installed such that their switching levers are accessible through the front plate for operation.

The single and triple pole MCCBs shall have short circuit rupturing capacity suitable for the distribution system as approved by the Engineer or as shown on the drawings. The MCCBs shall be suitable for working on lighting and power circuits.

4.2.3 Ammeters and Voltmeters

All meters shall be flush mounting, moving iron, spring controlled. The front dimensions shall be 96 x 96 mm for meters.

The meters shall be of accuracy class 1.5 according to BS-89 and 90. The ammeter shall be suitable for connection to 5 Amps secondary of current transformers or directly through shunt as shown on drawings. The ammeters and voltmeters shall have measuring range as indicated on the drawings.

4.2.4 Current Transformers

Air cooled, ring type current transformers shall be provided having transformation ratio as indicated on the drawings. The current transformers shall be of suitable burden having accuracy class 1.0 according to BS 3938. The current transformers shall have 5 amps secondary.

4.2.5 Selector Switches

The ammeter and voltmeter selector switches shall be complete with front plate, grip handle, R-Y-B and OFF position for ammeters, and RY-YB-BR-RN-YN-BN and OFF position for voltmeters shall be marked on the respective selector switches.

4.2.6 Air Break Contactors

The contactors shall be air break, triple pole 400 VAC type and suitable for the type of duty (at least utilization Category AC3) to be performed. The main contacts shall be silver tipped, butt type with double break per pole. Each contactor shall be provided with single phase 230 VAC operating coil and minimum one spare normally open and one normally closed auxiliary contact. The number of working auxiliary contacts shall be provided according to the system requirements.

4.2.7 Push Buttons

The push buttons shall be illuminated, momentary make/break contact type or latch type (push-on/push-off) as required and approved by the Engineer and suitable for flush mounting. The push button for ON and OFF switching shall be red and green respectively. They shall be provided as shown on the drawing.

4.2.8 Indicating Lamps

Indicating lamps shall be LED type suitable for flush mounting, complete with base. They shall be suitable for operation on 230 V AC and it shall have rosettes of suitable colours as approved by the Engineer. These shall be provided for R, Y, B phases on each distribution board.

4.2.9 Impulse Relay

Impulse Relay shall be 1 or 2 pole, 250 V rated and be provided with latching mechanism.

4.2.10 Line up Terminals

Line up terminals wherever provided for control or power circuits shall be suitable for voltage and size of conductors as indicated on drawing.

The line-up terminals for controls shall be suitable for channel mounting. All necessary accessories such as end plates, fixing clips, transparent label holder caps and label sheets with marking shall be provided.

5.0 INSTALLATION

The location of low tension distribution boards (DB) are shown diagrammatically on the drawings. The actual location shall be determined at site, keeping in view the site conditions and in co-ordination with other equipment, as approved by the Engineer.

Low tension distribution board for recessed mounting in wall shall be installed such that the door shall finish flush with the surface of wall. The recess mounted distribution board shall be installed before the plastering of walls. The DB shall be protected to avoid any damage due to the civil work. Any cuttings, dismantling of the existing wall required for fixing the DB shall be coordinated at site with the approval of Engineer. Any damage done to civil structure shall be made good by the Contractor.

All loose parts dispatched separately with the DB shall be installed as per manufacturer instructions and all adjustments or setting shall be made as required. All screws, nuts and bolts used for fixing the distribution board shall be galvanized.

The distribution boards installation shall include connecting all incoming and outgoing cables. The cable entry in the boards shall be provided from top or bottom as required and/or as approved by the Engineer.

The distribution boards shall be tested as per instructions contained in article "Testing" of General Specifications for Electrical Works, Section-8001 of these Specifications.

6.0 MEASUREMENT AND PAYMENT

6.1 General

The Contractor's bid amount against each item of Bill of Quantities as given below shall include design, fabrication, supply, installation, testing, commissioning and completion for all works specified herein and/or as shown on the Bidding Drawings related to the item.

6.2 LT Distribution Boards (DBs)

6.2.1 Measurement:

Measurement shall be made for the number of each LT Distribution Board acceptably supplied and installed by the Contractor as a complete job.

6.2.2 Payment:

Payment shall be made for the number of jobs measured, as

provided above, at the Contract unit price each and shall constitute full compensation for design, fabricating, supplying, installing, connecting, testing and commissioning of the LT Distribution Boards, including fixing arrangement, adapter box and other components/accessories for complete installation.

*** End of Section 8133 ***

SECTION - 8150

LIGHT FIXTURES

1.0 SCOPE OF WORK

2.0 GENERAL

3.0 APPLICABLE STANDARDS/CODES

4.0 MATERIAL

5.0 INSTALLATIONS

6.0 MEASUREMENT AND PAYMENT

1.0 SCOPE OF WORK

The work under this section consists of supplying, installing, testing and commissioning of all material and accessories of the complete Light fixtures as specified herein and/or shown on the Tender drawings and given 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 locations and positions of the light fixtures.

The lighting fixtures with accessories shall also comply with the General Specifications for Electrical Works, Section-8001 and with other relevant provisions of the Tender Document.

2.0 GENERAL

The description of light fixtures is given in the bill of quantities, and stated on the drawings, and all relevant material is described in this Section. The determination of quality is based on certified photo-metric data covering the coefficient of utilisation, light distribution curves, construction material, shape, finish, operation, etc.

The Contractor shall submit at least two samples of each and every light fixture specified and obtain approval of the Engineer before purchasing. The quality and finishes of the local make light fixtures (if mentioned in BOQ) shall be same as that of standard manufacturer. The accessories such as ballast, LED drivers, lamps, ignitors, etc., for all type of light fixtures shall be of make as stated in list of approved manufacturers. Approved equivalent against those specified will be accepted if the specified one is/will not be available. For any substitution the Engineer's approval is necessary.

All fixtures shall be finished in standard colour schemes as mentioned in the manufacturer's catalogue for respective fixtures, unless specifically stated in the Specifications, Drawings or Bill of Quantities or directed by the Engineer.

3.0 APPLICABLE STANDARDS/CODES

The latest editions of the following standards/codes shall be applicable to the material specified within the scope of this section:

IEC 60598-2-1-	Particular requirement- Fixed general purpose luminaire
IEC 60598-2-2-	Electrical Insulation Class I
IEC 62471 -	Photo biological Safety of lamps and lamps system
IEC 62031 -	LED modules for general lighting – Safety specifications

IESNA LM80	-	Testing report for LED Chips with TM21 extrapolation graph
IEC 61048 & 61049	-	Capacitors for use in TL, HP mercury and LP sodium vapour discharge lamp circuits.
IEC 60598 & BS EN 60598	-	Luminaires
BS 2560	-	Exit Signs
ISO 7010	-	Signs for the purposes of accident prevention, Fire protection, health hazard information and Emergency evacuation.

4.0 MATERIAL

4.1 LED Essential/Waterproof Batten Light Fixture:

The Contractor shall furnish and install the complete LED Batten luminaires replacement for complete single conventional 1x18W TL-D/1x36W TL-D & double 2x36W TL-D fluorescent batten. The batten light fixtures shall be of proper rating as shown on the drawings. The LED batten light fixture shall be 1200mm long for 36/28watts and 600mm long for 14watts respectively as specified.

The luminaire shall be cool white, with colour rendering and light colour of 840 characteristics. The luminaire shall have such distribution to achieve general lighting application parameters. The luminaire shall use high efficiency diffuser to achieve at least 50% energy savings compared to conventional fluorescent and waterproof light fixture. The luminaire shall offer a composite system efficiency of at least 90 Lumen/Watt for Essential LED batten and at least 100 Lumen/Watt for Waterproof LED batten having an average lumen package of up to:

3800 lumens ($\pm 5\%$) in 36W replacement for 2x36W waterproof TL-D Batten

2700 lumens ($\pm 5\%$) in 28W replacement for 2x36W fluorescent TL-D Batten

1350 lumens ($\pm 5\%$) in 14W replacement for 1x36W fluorescent TL-D Batten

The LED luminaire shall be designed for lumen maintenance of L70 or 70% at the end of useful life at ambient temperature of 25 deg. C. The complete luminaire shall have a useful life of 40,000 burning hours. The luminaire shall be suitable for ambient temperature range of between -20 to +40 degrees Celsius. Third party IEC 60598 Test Report shall be measured/corrected for $T_a = 25$ degrees Celsius. The luminaire including the driver will include a warranty of at least 3 years against

manufacturing defects.

The housing of Essential LED Batten light fixture will include integrated heat sink and optical system. The housing will be made of galvanized sheet having white Powder coated & suitable for indoor & semi-indoor environment. The optical cover made up of Polycarbonate with UV Protected Shielding cover. The fixing mechanism will be through clip made of Stainless steel. Appropriate size bushed wire entry holes, fixing holes, and earth terminal shall be provided. The driver shall be integrated within the luminaire.

The housing of Waterproof LED Batten light fixture will be made of Polycarbonate & extrusion process & suitable for outdoor environment. The optical cover made up of Polycarbonate with UV Protected Shielding cover. The product shall be protected against harsh industry environments IP65 rating for dust & water protection. The luminaire shall have no harmful effect against water projected from any direction. The luminaire shall have impact protection classified as IK07 operating temperature. The driver shall be integrated with the luminaire in a separate gear compartment with similar Index protection.

The internal wiring of LED batten light fixtures shall be done with heat resistant wires at the manufacturer's factory. The internal wiring shall be clipped properly and heat resistant sleeves be provided on cables passing near driver. Connectors suitable for connecting 2.5 sq.mm cable conductors shall be provided for supply connections. An earth terminal for connection to 2.5-sq.mm cable conductor shall be provided.

The light fixtures shall be furnished with Perspex diffusing panels "040 opal acrylic" (minimum sheet thickness 3mm) etc. as specified on the drawings or in BOQ. The luminaire shall have provision of both surface, Suspended mounting with dimension compatible to conventional florescent fixture. Mounting Clips for installation must be available.

IP degree of Protection shall comply with the requirements laid down in Section 8001. Standard luminaries with manufacturer's recommended modifications, such as additional gasket, etc., shall be provided to attain required protection level.

4.2 LED Smart Panel Light Fixture:

The Contractor shall furnish and install the complete LED Panel luminaires as replacement for complete double conventional 2x36W TL-D fluorescent light fixture. The Smart Panel shall be of proper rating as shown on the drawings. The LED Panel shall have dimensions of 297 x 1197 x 75mm/595 x 595 x 75mm for 36 watts respectively as specified.

The luminaire shall be cool white, with colour rendering and light colour of

840 characteristics. The LED shall have a colour consistency preferably within 5 SDCM (standard deviation of colour matching) as defined by McAdam. The colour temperature variation should be restricted as per ANSI C78.377A with CCT variation limiting within 500K for nominal CCT of 4000K / 6500K.

The luminaire shall offer a composite system efficiency of at least 110 Lumen/Watt and a lumen package of up to 3,800 lumens ($\pm 5\%$) in 36W replacement for 2x36W conventional TL-D fluorescent fixture. The luminaire shall use high efficiency diffuser and reflector to achieve at least 50% energy savings compared to conventional fluorescent light fixture.

The system should be designed for fully hospital and office lighting & possess higher uniformity to have a smooth white light of high colour consistency & high system efficiency. For the better UGR control one, the luminaire optics should fully comply with hospital lighting norms with UGR value (Unified Glare Rating) < 25 . The beam angle of the optic should be around 140° .

The LED luminaire shall be designed for lumen maintenance of L70 or 70% at the end of useful life at ambient temperature of 25 deg. C. The complete luminaire shall have a useful life of 50,000 burning hours. The luminaire shall be suitable for ambient temperature range of between -20 to +40 degrees Celsius. Third party IEC60598 Test Report shall be measured/corrected for $T_a = 25$ degrees Celsius. The luminaire including the driver will include a warranty of at least 3 years against manufacturing defects.

The housing will include integrated heat sink and optical system. The housing will be made of electrogalvanized cold rolled steel sheet, pre-treated, painted and stove enamelled in white colour & the fixture will be provided with a plastic cover that is aesthetical for the hospital environment. The heat sink will design in such way to create better air-flow for better heat transfer. The light cover is made up of PMMA optics lens with PS diffuser & a suitable reflector for the best uniformity. Appropriate size bushed wire entry holes, fixing holes, and earth terminal shall be provided. The driver shall be integrated within the luminaire.

The internal wiring of LED batten light fixtures shall be done with heat resistant wires at the manufacturer's factory. The internal wiring shall be clipped properly and heat resistant sleeves be provided on cables passing near driver. Connectors suitable for connecting 2.5 sq.mm cable conductors shall be provided for supply connections. An earth terminal for connection to 2.5-sq.mm cable conductor shall be provided.

The luminaire shall have provision of recessed, surface or suspended mounting etc. as specified on the drawings or in BOQ with dimension

compatible to conventional florescent fixture. Mounting Clips for installation must be available. Shop drawings shall be submitted by contractor for approval of Engineer.

4.3 LED Down Light Fixtures

The Contractor shall furnish and install the surface mounted LED Downlight luminaires as replacement for single 1x18W or double conventional 2x18W PL-C incandescent/ compact fluorescent light fixture. The LED downlights shall be of proper rating as shown on the drawings. The LED Downlights shall have dimensions of 122/167/218mm dia. for 7/11.5/16 watts respectively as specified.

The luminaire shall be cool white, with colour rendering index greater than 80 and light colour of 840 characteristics. The Downlighter must be provided with a polycarbonate diffuser having high haze and light transmission for uniform light output. The beam angle must be in the ranges in between 95 to 100 degrees for better illumination.

The LED downlights shall have minimum system efficacy of at least 95 lm/W with 55% energy-saving as compared with conventional compact fluorescent lamp downlight fixtures and shall have a useful life of 50,000 burning hours for 70% lumen maintenance at the end of useful life at ambient temperature of 25 deg. C.

The downlighter shall have high reflectance white painted polycarbonate front element or High purity aluminium with high reflectance coated reflector along with tempered glass on the front cover. The housing will include integrated heat sink and optical system. The heat sink made with Die Cast Aluminum should be design in such way to create better air-flow for better heat transfer as furnished by the manufacturer or as specified in the drawings or BOQ. The fixing mechanism of recessed down light will be through spring fasteners.

Where surface mounted downlights are used, the housing will be made of Plastic and enclosed in white powder coated die-cast aluminium body for surface mounting installation. The body shall have fins as heat sink.

The types of fixtures with manufacturer's catalogue reference are given on the fixture schedule and in bill of quantities. Equivalent fixture may be acceptable provided that the contractor submits for review all necessary data indicating photometric curves to show that the fixture proposed are of the same type, construction and quality.

4.4 Compact Fluorescent Light Fixtures

The compact fluorescent light fixtures shall be as stated on drawings and bill of quantities. The light fixture shall be finished in standard colours

unless otherwise stated on drawings or directed by Engineer. All compact fluorescent light fixtures shall be of international standard and quality.

The lamps for compact fluorescent light fixtures shall be CFL type with normal or electronic control gear and shall be supplied and installed according to the wattage/type as indicated on drawings.

Weatherproof bulkhead incandescent/compact fluorescent light fixture shall comprise of plastic body and gasketed clear glass cover secured to the body by means of wing nuts/screws to give a weatherproof and watertight fit. The gasket shall be weather resistance type. The lamp holder shall be of bi-pin brass having porcelain outer ring or 2/4-pin base for compact fluorescent lamps with normal control gear as per requirements.

The glass shade of the light fixtures shall be opal white or clear as furnished by the manufacturer with the light fixture unless specified and free from any air bubbles or voids. The shade may be spherical, cylindrical, flattened bottom or any other shape as specified in the drawings or BOQ.

4.5 Exit Sign – Emergency Light Fixture

The exit sign emergency light fixture shall be maintained type with self contained, polycarbonate body, Gear Type and sealed nickel metal hydride batteries providing a backup of atleast 3 hours if not mentioned otherwise elsewhere. The light fixture shall have steel body powder coated in perma white finish, complete with screen printed acrylic legend panel. 2 X High Power 1W LED lamp and give 20 m route space. Legend panel shall be bottom entry for case of installation near walls. The legend pictogram shall be green colour and as approved by the Engineer.

4.6 LED Flood Light Fixture

The Contractor shall furnish and install the complete Boundary Wall luminaires maintaining avg. 30 lux for existing outdoor mixed traffic area, fully IP 66 with corrosion resistant die cast aluminum housing, silicon gas kit, thermally hardened glass complete with LED drivers, surge protection and all accessories/ components required for the proper operation of the system. The luminaries shall be fully flexible for future upgrades and easy replacements for maintenance purposes.

The luminaire shall have such distribution to achieve flood lighting application parameters. The luminaire shall offer a composite system efficiency of at least 100 Lumen/Watt and a lumen package of up to 13,000 for 120W+/-5W. The light fixture have three different optical beam angles Symmetric Wide Beam & Asymmetric Medium Beam & Narrow Beam optics according to application.

The LED light fixture should be designed for lumen maintenance of L70 or 70% at the end of useful life at ambient temperature of 45 °C and shall be capable to operate efficiently within the temperature limit of -40 °C to 50 °C. The complete light fixture should have useful life of 50,000 burning hours.

4.7 High Pressure Sodium Lamp

The high-pressure sodium SON-T plus lamp shall be of increased output tubular of rating 70 Watt and 400 watt as shown on the drawings. The base of the lamp shall be E40 with 6600 and 55,000 lumens output for 70 Watt and 400 Watt lamps respectively. The colour-rendering index Ra shall be 23. These lamps shall comply with EN60662.

4.8 Ballast for High Pressure Sodium Lamps

The ballast for high pressure Sodium lamps shall be polyester resin filled, totally encapsulated electromagnetic of copper / iron construction with leak proof body for use in combination with an external ignitor. The ballast shall fully comply with international Standards on Safety and performance, design compliance to IEC 60922/60923. The ballast shall be suitable for application in luminaries or poles under normal humid conditions. The ballast shall conform to the characteristics and wattage of the lamps. The wattage of lamp and ballast and a wiring diagram and other relevant data shall be printed on the body of the ballast. The power loss of the ballast shall not be more than 13.5-Watts for 70-Watts lamp and 28-Watts for 400-Watts lamp. The ballast shall be provided with insulated block of terminals for connecting up to 6 sq.mm cable with separate earth terminal.

4.9 Electronic Ignitors for High Pressure Sodium Lamps

The electronic ignitors for high-pressure sodium lamps shall be compact and light in weight with reliable and smooth starting behaviour. The ignitors shall be suitable for specified wattage of high-pressure sodium lamps and other requirements. The ignitors shall fully comply with IEC 60662 and EN 60926 regulations. The ignitors shall be provided with screw terminal / blocks and simple stud or screw mounting arrangement.

4.10 Capacitors for High Pressure Sodium Lamps

The capacitors for use in combination with high-pressure sodium lamp circuits shall be high-quality electrolytic capacitors for correction of power factor. The capacitors shall be of appropriate rating and type for the relevant lamp wattage. All capacitors shall be fitted with an internal discharge resistor, have a fuse fitted and be of self-healing type. Capacitor shall conform to IEC 61048/61049.

4.11 Flood Light Lanterns

The flood light lanterns shall have lamps of ratings specified in BOQ/ Drawings and shall be fully equipped with high grade reflector, corrosion proof housing with integral gear box, (Double insulation Class-II), compensated electrical control gear etc. complete with all internal wiring.

The flood light lanterns shall have non-corrosive, injection moulded, heat and UV-stabilized body, hammered aluminium reflector brightened and anodised, thermally – hardened 5 mm minimum glass, stainless steel snap-on hinged-clips, stainless steel protractor, hot dipped galvanized steel mounting brackets and stainless steel fixing accessories.

The housing shall be dust proof and jet proof to IP66, such that no internal cleaning shall be required.

4.12 LED Street Light Fixture

The road light fixture shall be an attractive modern appearance, high performance lantern suitable for 90W or 200W LED lamp as given in the BOQ/drawing.

Light fixture shall be provided with solid die cast aluminium housing, heat resistant silicon rubber gasket in optical LED compartment, DME type optic, tampered glass cover and shall be coated with powder of colour RAL 7040 ensuring no discoloration when exposed to UV light.

The light fixture shall be designed to receive power either from the battery or from the AC source. The light fixture shall have the following characteristics:

Voltage	=	220-240 VAC
Surge Protector	=	10 kV
Power Factor	>	0.9 (nominal power)

The light fixture shall have IP 66 protection to ensure long reliable performance and minimize maintenance requirement and an Impact resistance of IK 08 with insulation Class I. Use of chemical glue shall NOT be allowed to avoid probable breakdown of water-proof and dust-proof seal.

The light fixture should have a minimum color rendering index (Ra) of 70 + 5 and a color temperature of 4000K for maximum efficacy with an average output of at least 10,000 lumens for 90 Watt and 22,000 lumens for 200 Watt LED Fixture. The LED should have a color consistency within 5 SDCM (Standard Deviation of Color Matching). The color temperature variation of the LEDs should be restricted as per ANSI

C78.377A with CCT variation limiting within 500K for nominal CCT of 4000K.

The LED light fixture should be designed for lumen maintenance of L70 or 70% at the end of useful life at ambient temperature of 45 °C and shall be capable to operate efficiently within the temperature limit of -40 °C to 55 °C. The complete light fixture should have useful life of 50,000 burning hours.

The light fixture shall be fully compatible with future LED upgrades when they become available. It shall have a modular design to upgrade / replace with new LED modules or LED drivers at site conveniently with minimum effort. All electronic components/drivers shall be mounted on a separate removable gear tray. Light fixture housing shall have a tool less access by opening the cover.

The proposed LED road lighting light fixture shall be provided with in-built surge protection system to protect the electronic driver and LED system. Minimum surge protection rating is 10kV.

The housing shell, under the circuit board, shall be specially designed to ensure perfect contact between the circuit board and the light fixture housing for efficient heat dissipation. Only Metal Core PCBs shall be used to maximize heat transfer process and to offer reinforced electrical insulation via di-electric layer. The Metal Core PCB should be mounted on the housing using a highly efficient thermal interface material.

The optical LED compartment shall have a thermally hardened glass cover and high quality silicon gasket. The Glass cover will be tightly secured with the housing. The light fixture should have flexible optical system to achieve lighting parameters for required class of roads. The light fixture should offer a composite system efficiency of at least 100 lumen/Watt.

Specially designed lens system with unique inner and outer profile for high efficiency LED shall be provided to ensure maximum spacing between the poles and cover higher road widths. Multi layer optics design to ensure adequate luminance and luminance uniformity in the unlikely event of individual LED failure. The light fixture should offer choice of narrow, medium and wide beam light distribution.

The lamp position shall be adjustable to at least three positions to facilitate the changing of photometric distributions.. The photometric data of the lantern shall be authenticated by an Internationally Accredited Lighting Organisation.

Luminance level calculation with average luminance of the road surface, overall uniformity of road luminance, threshold increment, longitudinal

uniformity of road surface luminance and surround ratio achieved shall be submitted by the Contractor / manufacturer for verifying conformance to international lighting standards and approval of the Engineer.

4.13 LED Chips and Driver

The LED chip shall be from Cree / Nichia / Lumileds make or approved equivalent. The LED driver shall be designed to operate large array of high power LED's through current controlled output. The driver shall be suitable for operate up to 250VAC 50/60Hz mains supply. The LED driver shall have an efficiency of at least 90%. Fixed Output LED Driver (PSU) shall be integrated within each LED luminaire. The Driver compartment cavity and gear tray shall be designed with tool-less access for maintenance and replacement.

The light fixtures including the driver will include a warranty of at least 3 years against manufacturing defects. The cost of such provision will deemed to have been respective BOQ item of light fixture and no separate payment shall be admissible in this regard.

The LED driver shall fully conform to following specifications:-

- 1) BS-EN 61347-1 - General and safety requirements.
- 2) BS-EN 61347-2-13 - Particular requirements for DC or AC supplied electronic control gear for LED modules.
- 3) BS EN 55015: 2013 – Emission – Electrical lighting and similar equipment
- 4) BS EN 61547: 2009 – Immunity – Equipment for general lighting purpose
- 5) BS EN 61000-3-2: 2009 – Limits for harmonic currents emissions.
- 6) BS EN 61000-3-3: 2008 – Limits for voltage fluctuation and flicker.
- 7) BS EN 62493 – Assessment of lighting equipment related to human exposure to electromagnetic fields

5.0 INSTALLATION

5.1 General

The mounting heights of light fixtures are indicated on the drawings, and positions of fixtures are according to the mentioned scale.

The Contractor must ensure that the light fixtures are installed uniformly with respect to the dimensions of the area. Any modifications due to site conditions may be made with the approval of Engineer. All fixtures shall be carefully aligned before fixing in position.

The wiring between ceiling rose or terminal box and the fixture shall be carried out with 3-core 1.0 sq.mm and 1.5-sq.mm flexible copper

conductor PVC/PVC cable respectively for circuits protected by 10 amps and 15/20 amps MCBs. The wiring inside light fixture body shall be done with heat resistant cables or PVC insulated cable in heat resistant sleeves as approved by the Engineer.

Glasses, shades, reflectors, diffusers, etc., must be in a clear condition after installation. All light fixtures shall be earthed by an earth wire connected to the earth terminal in the fixture.

5.2 Street Light / Flood Light Fixture

The proposed street light fixture / flood light fixture shall be installed on the light pole/mast as per manufacturer's installation instructions. The road light fixture shall be properly levelled and the lamp adjusted to the appropriate position and all screws, bolts checked for tightness, etc. The light fixture shall be connected to the supply and earth at the proper terminals in the fixture.

5.3 Flood Light Lanterns

The flood light lanterns shall be installed on truss/G.I. bracket as per details shown on the drawing. Manufacturer's installation instructions shall be followed. The G.I. bracket shall be installed on column as shown on drawing. The exact location, rating and tilt/pan angles of light fixtures shall be finalized at site to suit the flood lighting requirements. Engineer's decision will be binding and final.

5.4 LED Batten / Panel Light Fixture:

LED Batten or Panel light fixtures on the surface of ceiling shall be installed with the back of the body flush with the ceiling surface, and in a manner so as to facilitate wiring. Nylon plugs and galvanized steel bolts or screws shall be used for fixing the light fixture to the ceiling. For light fixtures installation on false ceiling the installation method/detail shall be coordinated with ceiling design and submitted for approval of Engineer. Care shall be taken to prevent the weight of the fixture from being transferred to the false ceiling.

Pendant light fixtures shall have two holes in the top of each casing for supporting to the ceiling by a 3/4" dia. galvanized pipe or any other standard method as approved by the Engineer. Wiring from ceiling rose to the fixture shall be done through the pipe. Proper arrangements such as long threads with check nuts, etc. for minor adjustment in the mounting heights of the fixtures shall also be provided.

5.5 LED Down Light Fixture

LED downlight fixtures shall be installed on the surface of ceiling or wall by means of nylon plugs and galvanized steel screws, such that their

back finish flush with the surface for exposed conduits and flush with outlet box for concealed conduit system. Wherever convenient, screws for fixing light fixtures shall be screwed into the holes of the outlet box. The lights on false ceiling shall be installed in a manner as described for LED Panel light fixture.

6.0 MEASUREMENT AND PAYMENT

6.1 General

The Contractor's bid amount against each Bill of Quantities item as given below shall include supply, installation, testing, commissioning and completion for all work specified herein and/or shown on the Bidding Drawings related to the item.

6.2 LED Batten / LED Smart Panel / LED Downlight / LED Exit Light / CFL Bulkhead / LED or Conventional Flood Light/ LED Street Light Fixture

The Contractor's bid amount against each Bill of Quantities item as given below shall include supply, installation, testing, commissioning and completion for all work specified herein and/or shown on the Bidding Drawings related to the item.

6.2.1 Measurement

Measurement shall be made for each type of light fixture including all accessories acceptably supplied and installed by the Contractor as complete unit.

6.2.2 Payment

Payment shall be made for the number of units measured as provided above at the contract unit price each and constitute full compensation for supplying, installing, connecting, testing and completion of LED Battens / LED Smart Panel / LED Downlight / LED Exit Sign / compact fluorescent Bulkhead including all accessories such as capacitors , LED drivers, LED Chips, LED optics, connecting cables & connectors, suspension rods and pendent arrangement, GI pipe bracket, ceiling supports, internal wiring, nuts, bolts, screws, etc., as required and complete in all respects.

6.3 High Pressure Sodium Flood Light/ LED Flood Light / LED Street Light Fixture

The Contractor's bid amount against each Bill of Quantities item as given below shall include supply, installation, testing, commissioning and completion for all work specified herein and/or

shown on the Bidding Drawings related to the item.

6.3.1 Measurement

Measurement shall be made for each type of light fixture including all accessories acceptably supplied and installed by the Contractor as complete unit.

6.3.2 Payment

Payment shall be made for the number of units measured as provided above at the contract unit price each and constitute full compensation for supplying, installing, connecting, testing and completion of High Pressure Sodium Flood Light / LED Flood Light Fixtures/ LED Street lights including all accessories such as ballasts, capacitors, igniters, LED drivers, nuts, bolts, screws, etc., including PVC pipe, foundation etc., as required and complete in all respects.

*** End of Section 8150***

SECTION - 8240

EARTHING

- 1.0 SCOPE OF WORK**
- 2.0 GENERAL**
- 3.0 APPLICABLE STANDARDS/CODES**
- 4.0 MATERIAL**
- 5.0 INSTALLATIONS**
- 6.0 MEASUREMENT AND PAYMENT**

1.0 SCOPE OF WORK

The work under this section consists of supplying, installing, testing and commissioning of all material and services of the complete Earthing system as specified herein, as shown on the Tender Drawings and given 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 earth electrode and ECC etc.

The Earthing system shall also comply with the General Specifications for Electrical Works Section - 8001 and with other relevant provisions of the Tender Documents.

2.0 GENERAL

The earthing system consists of earth electrodes, earthing leads, earth connecting points, earth continuity conductors and all accessories necessary for the satisfactory operation of the associated electrical system.

3.0 APPLICABLE STANDARDS/CODES

The latest editions of following standards / codes shall be applicable for the materials specified within the scope of this section:

BS 951	-	Earthing clamps
BS 7430	-	Earthing
BS 2874	-	Nuts, bolts, washers, screws and rivets fixing for use on copper
BS 6346	-	PVC insulated cables

4.0 MATERIAL

4.1 Earth Electrode

4.1.1 Plate Type

Earth Electrode for earthing shall comprise of 75 mm x 4877 mm x 6 mm thick copper plate with 4 Nos. 6 mm dia brass nuts, bolts and washers 70 sqmm HDHC Copper wire as earthing leads. A 100 mm dia Medium Duty GI pipe shall be used with 10 mm dia holes @500 mm c-c. The total length of this GI pipe should be 45 ft.

A 150 mm dia 60 ft long hole should be drilled in ground by percussion method and above mentioned 100 mm dia medium duty GI pipe should be fixed in this hole simultaneously up to the depth of 45 ft from NSL.

When the drilling up to 60 ft depth is complete, The above mentioned earth electrode shall be drop down to the bottom of the hole with the help of 2 Nos 70 sqmm earth leads. Once the plate is in place fill in the hole with moisture retaining bentonite slurry with tremie method up to the top. When the bentonite settle down cast a (1:4:8) concrete manhole 700 mm x 700 mm & 500 mm deep as shown in the drawing. Place a medium duty CI cover as shown in the drawing.

4.1.2 Copper Clad Steel Rod Type

This type of earth electrode shall comprise a 3 metre long, 20 mm dia. copper clad steel rod having flat head at drive end and pointed conical tip at the driven end. The tip shall be hardened to facilitate driving. At the top of the rod, a brass clamp for bolted connections shall be provided suitable for connection to the down conductor or earthing lead as required. The thickness of Cu coating on the Galvanized Steel Rod should be 250 micron.

The inspection chamber with C.I. cover shall be provided as instructed by the Engineer.

4.2 Earthing Lead

The earthing lead shall connect the earth electrode to earth connecting point or equipment in the building. It shall be of stranded bare electrolytic copper of size shown on the drawings. The cost of earthing leads deemed to have been included in the price of earth electrode and no separate payment shall be made for it.

4.3 Earth Continuity Conductor

Earth continuity conductor (ECC) shall be stranded bare copper wire or single core PVC insulated copper conductor cable of sizes indicated on the drawings. All thimbles, lugs, sockets, nuts, washers & other accessories necessary for the complete installation of ECC shall be provided by the Contractor without any extra cost.

The specifications for single core PVC insulated cables used as ECC shall be same as those given in section "LT Cables" of the technical specifications. PVC insulated cables when used as ECC shall be green or green/yellow.

4.4 **Earth Connecting Point**

Earth connecting points shall comprise tinned copper bar, rectangular in shape, having dimensions of 300 x 50 x 6 mm. At least six terminals for connection shall be arranged on the bar, which can be increased or decreased as required by the Engineer.

The terminals shall have brass or tinned copper bolts, nuts and washers for protection against corrosion. Two holes shall be provided off centre of the copper bar for fixing to the wall by means of 10 mm dia. nut and bolt and shall be insulated by means of rubber gaskets/washers.

5.0 **INSTALLATION**

5.1 **General**

Complete earthing systems as shown on the drawing shall be installed by the Contractor. The earthing system shall give earth resistance, including the resistance of soil, earth leads and ECC equal to or less than one ohm.

At all connections of earth continuity conductor to Generator, Transformer, LT Switch Board, LT Distribution Board, or any other metallic body, proper size copper or brass sockets, thimbles or lugs shall be used to which the copper wire shall be connected by copper brazing. The soldering of copper wire at joints or terminations shall not be allowed. All tee-off connections shall be by copper brazing using suitable socket and clamps. After brazing, the jointed surface shall be protected by oxide inhibiting compound of low electrical resistance. For connections to metallic body, the surface shall be thoroughly cleaned before bolting the lug or socket.

The earth continuity conductor shall in general run in cable trench or in conduits/pipes as shown on the drawings. For under floor runs, these shall be installed in pipe/conduit of appropriate sizes. Where laid along underground cables, these shall be laid directly underground in unpaved areas and in pipes under paved areas.

The earthing system shall be tested after complete installation of earth electrodes.

5.2 **Earth Electrode**

5.2.1 Plate Type

The electrode plate shall be installed at a minimum depth of 5 metres from finished ground level or 1 metre below permanent water level whichever is less. The minimum horizontal distance between earth electrodes shall be 3 metres. Bentonite slurry with tremie method shall be made and buried alongwith the copper

plate in the ground to increase the soil conductivity. The electrode shall be installed as per details shown on the drawings. The inspection chambers shall be constructed at locations approved by the Engineer.

5.2.2 Copper Clad Steel Rod Type

In case the soil conditions at site permit and approved by the Engineer this type of earth electrode may be installed by hammering the electrode in soil, until the top of the rod is about 300 mm below the proposed finished ground level. If hammering down of rod is not possible due to site conditions, a pit shall be first excavated in bare ground upto the required depth and electrode shall be installed upright in the pit. The excavated pit shall be backfilled in layers of 500 mm, each layer tamped and compacted.

5.3 **Earth Continuity Conductor**

The earth continuity conductor of sizes shown on the drawing shall be installed all along the cable runs and connected to the earthing bar/terminals provided in equipment. The body of generator, transformer and all switchboards shall also be connected to earth by specified size of ECC. All other metal work shall also be connected to earth by specified size of ECC.

At any joint or terminations, the ECC shall be connected using proper accessories. No connection shall be made by twisting of earth conductors.

5.4 **Earth Connecting Point**

The earth connecting point shall be installed at locations shown on the drawings. It shall be fixed on wall surface by means of brass screws with nuts, washers and other insulating material as instructed by the Engineer.

6.0 **MEASUREMENT AND PAYMENT**

6.1 **General**

The Contractor's bid amount against each Bill of Quantities item as given below shall include supplying, installation, testing, and commissioning of all work specified herein, as shown on the Tender drawing related to the item.

6.2 **Earth Electrode**

6.2.1 Measurement:

Measurement shall be made for the total no. of each type of earth electrode acceptably supplied and installed by the Contractor as a complete unit.

6.2.2 Payment:

Payment shall be made for the number of units measured, as provided above, at the Contract unit price each, and shall constitute full compensation for supplying, installing, testing, commissioning and completion of earth electrodes including copper plate or copper clad steel rod, earthing leads, excavation, backfilling, lime and charcoal, inspection chamber with cover, GI pipes for earthing leads/watering, nuts, bolts, washers, lugs, brazing and all related civil works.

6.3 **Earth Continuity Conductor (ECC)**

6.3.1 Measurement:

Measurement shall be made for the total running feet of each size and type of earth continuity conductor (ECC) acceptably supplied and installed by the Contractor.

6.3.2 Payment:

Payment shall be made for the total running feet of each size and type of ECC measured, as provided above, at the Contract unit price and shall constitute full compensation for supplying, installing, connecting, testing and completing of ECC including all accessories such as sockets, thimbles, lugs, bolts, nuts, washers, brazing, etc.

6.4 **Earth Connecting Point**

6.4.1 Measurement:

Measurement shall be made for the total no. of earth connecting points acceptably supplied and installed by the Contractor as a complete unit.

6.4.2 Payment:

Payment shall be made for the total number of units measured, as provided above, at the Contract unit price each and shall

constitute full compensation for supplying, installing and completion of earth connecting point and all other associated accessories such as nuts, bolts, washers, lugs, etc.

*** End of Section 8240 ***

SECTION - 8290

MISCELLANEOUS ITEMS

- 1.0 SCOPE OF WORK**
- 2.0 GENERAL**
- 3.0 APPLICABLE STANDARDS/CODES**
- 4.0 MATERIAL**
- 5.0 INSTALLATIONS**
- 6.0 MEASUREMENT AND PAYMENT**

1.0 SCOPE OF WORK

The work under this section consists of supplying, installing, testing and commissioning of all material and accessories for Miscellaneous Items as specified herein and/or shown on the Bidding drawings and stated in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and coordinate at site with other services for exact locations and positions of the Miscellaneous Items.

The Miscellaneous Items with accessories shall also comply with the General Specifications for Electrical Works, Section - 8001 and with other relevant provisions of the Bidding Document.

2.0 GENERAL

The Miscellaneous Items as described in this section shall comply with other sections of these specifications as applicable. The Contractor shall ensure that all the miscellaneous items be supplied/fabricated from the reputable manufacturers, who have already supplied/fabricated similar items.

3.0 APPLICABLE STANDARDS/CODES

The latest editions of the following standards/codes shall be applicable to the material specified within the scope of this section:

- IEC 60947-2 - Low Voltage Switch Gear and Control Gear.
- BS 729 - Hot dip galvanization
- BS 4934 - Safety requirements for electric fans and regulators.
- BS 5060 - Performance of circulating fans and their regulators.
- BS EN 50085 - Cable trunking and cable ducting systems for electrical installations.
- BS EN 61537 - Cable tray systems and cable ladder systems for cable management

4.0 MATERIAL

4.1 MCCB / MCB Enclosed in Sheet Steel Box

The single / double pole 250 volts miniature circuit breaker (MCB) and triple pole 500 volts moulded case circuit breakers (MCCB) are used for supplying single phase and three phase power respectively to the equipment shown on the drawings and given in the Bill of Quantities.

The MCCB/MCB shall conform to the same specifications as given in section LT switchboards and LT distribution boards of these specifications. It shall be installed in a 16 SWG sheet steel box of such a size, which can easily accommodate the MCCB/MCB and incoming/outgoing wires or cables. Sufficient numbers of PVC connectors shall also be provided inside the sheet steel box for terminating the earth continuity conductors and neutral wires. The front plate fixed on the sheet steel box shall be of white plastic fixed with G.I. screws having an opening for operating the ON-OFF lever of MCCB / MCB.

4.2 Load Break Switch Enclosed in Sheet Steel Box

Single pole 250 Volts and triple pole 500 Volts Load Break Switch Enclosed in Sheet Steel Box are used for supplying single phase and three phase power respectively to the equipment shown on the drawings and given in the Bill of Quantities.

The load break switch shall conform to the same Specifications as given in section LT switchboard and LT distribution boards of these Specifications. It shall be housed in a, manufacturer's standard and in such a size of box which can easily accommodate the load break switch and incoming / outgoing wires alongwith the earth continuity conductor and neutral wires terminals.

4.3 Exhaust Fans

Exhaust fans shall be three blade or multi blade type of metal / PVC construction as approved by the Engineer.

Fans shall be direct driven and supplied complete with electric motor, back draft dampers and anti-vermin screen.

The bearings shall be ball roller or sleeves type of permanently lubricated and sealed type.

Wheels shall be heavily and rigidly constructed and accurately balanced both statically and dynamically and be free from objectionable vibration or noises.

4.4 Cable Trays / Trunking

Where specified, the cables shall run on cable trays/trunking supported to the wall and/or ceiling. The tray shall be of appropriate dimensions to ensure minimum clearance of 50mm between the cables. Tray and trunking shall be provided with complete accessories such as straight through joint, flexible expansion coupler, tee, cross, internal and external bend, cover etc. complete with proper support and fixing accessories, GI nuts, bolts washer etc.

The cable tray/ trunking length shall be fabricated in sections not exceeding 3.0 metres.

4.4.1 M.S. (Mild Steel) Cable Trunking

The M.S. cable trunking (with cover) shall be 16 SWG M.S. sheets. Suitable trunking design shall be provided for bends, crossings, etc., keeping in view allowable bending radius of cables.

Arrangement shall be provided to secure the cables in position on the trunking. After fabrication of each trunking and cover section, the metalwork shall be cleaned down to bare shining metal phosphated and the surface chemically prepared for powder coating. Then these shall be coated with powder of RAL colour as approved by the Engineer and then baked in oven. The thickness of powder coating shall not be less than 100 microns.

4.4.2 G.I. (Galvanized Iron) Trays/Cable Trunking

The G.I. trays/cable trunking shall comprise of 16 SWG perforated G.I. Sheets with solid cover, bend to shape and having required dimensions and all accessories shall be compatible with the tray to make a smooth medium.

Cables laid on tray or trunking shall be properly fixed or clamped, with smooth finished split pieces with bore diameter to suit the cable. Supports shall be arranged as far as practicable for easy removal of any cable without disturbing other cables.

Flexible copper braid connections shall be provided at every joint, fixing accessories of cable tray to ensure continuity.

5.0 **INSTALLATION**

5.1 **General**

The mounting heights, depths and other dimensions of all the Miscellaneous Items are stated on the drawings or in general notes. In case of any discrepancy, the instructions of the Engineer shall be obtained before fixing the item.

5.2 **MCCB / MCB Enclosed in Sheet Steel Box**

The triple pole moulded case circuit breakers (MCCB) single/double pole miniature circuit breakers (MCB) shall be installed on 1.63 mm (16 SWG) thick sheet steel box with screws or some suitable arrangements as approved by Engineer. White faceplate for sheet steel box shall be fixed by means of flat head galvanized screws sunk in the plastic plate so as to finish flush with the wall surface. The edges of the plate shall be chamfered.

5.3 **Load Break Switch Enclosed in Sheet Steel Box**

The load break switch shall be installed as per manufacturer's recommendation and site conditions following good engineering practice.

5.4 **Exhaust Fan**

The propeller exhaust fan shall be installed in the opening already made in the wall and shall be firmly fixed by means of flat and head galvanized screws.

Wiring between the ceiling rose and the fan terminals shall be with atleast three core 2.5 sq.mm PVC insulated PVC sheathed flexible cables.

5.5 **Cable Trays/Trunking**

The cable trays/trunking shall be installed on supports fixed to the wall and/or ceilings/trusses. The supports shall be fixed by means of Rawl bolts suitable to carry maximum expected load. The additional hangers and other metalwork required for the installation of the trays / trunking shall be galvanized / painted and finished by method as specified for the cable tray / trunking.

The distance between alternate supports (span) in straight runs shall be finalized as per loading and in no case shall exceed 1.2 metres. In addition to these, supports shall be provided near each bend or change in direction or at the end of trunking / tray.

The straight jointing, bends and other accessories shall be fixed with cable tray/ trunking in such a manner that they are in one line with no sharp edges/ protruded surfaces. Rivet head nuts shall be installed on inner side of tray/ trunking.

On straight lengths (Over 20 meters) and at every building expansion joint suitable flexible expansion couplers shall be provided.

At each joint, bend earth continuity shall be ensured by using copper earth braid and copper lugs in electro-tinned finish.

6.0 MEASUREMENT AND PAYMENT

6.1 General

The Contractor's bid amount against each Bill of Quantities item as given below shall include supply, installation, testing, commissioning and completion for all work specified herein, as shown on the Bidding Drawings and given in the Bill of Quantities related to the item.

6.2 **MCCB / MCB and Load Break Switch Enclosed in Sheet Steel Box**

6.2.1 Measurement:

Measurement shall be made for the number of each item acceptably supplied and installed by the Contractor as a complete unit.

6.2.2 Payment:

Payment shall be made for the number of units measured as provided above at the Contract unit price each and shall constitute full compensation for supplying, installing, connecting, testing and completion of each item including sheet steel outlet box, plate and accessories as required.

6.3 **Exhaust Fan**

6.3.1 Measurement:

Measurement shall be made for exhaust fan & Accessories acceptably supplied and installed by the Contractor as a complete unit.

6.3.2 Payment:

Payment shall be made for the number of units measured as provided above at the Contract unit price each and shall constitute full compensation for supplying, installing, connecting, testing and commissioning of exhaust fans including mounting accessories, nuts, bolts, etc. and wiring between ceiling rose and fan terminals complete in all respects.

6.4 **Cable Trays/Cable Trunking**

6.4.1 Measurement:

Measurement shall be made of the total running meter of each size of cable tray/cable trunking with cover and all accessories acceptably supplied and installed by the contractor.

6.4.2 Payment:

Payment shall be made for the total running meter as provided above at the contract unit price and shall constitute full compensation for supplying, installing, and completion of each size of cable tray/cable trunking with cover complete with all

installation material and accessories such as mounting brackets, bends, elbows, nuts and bolts etc.

*** End of Section 8290***

SECTION – 8312

STRUCTURED CABLING NETWORK

- 1.0 SCOPE OF WORK**
- 2.0 GENERAL**
- 3.0 APPLICABLE STANDARDS/CODES**
- 4.0 MATERIAL**
- 5.0 INSTALLATIONS**
- 6.0 TESTING AND COMMISSIONING**
- 7.0 MEASUREMENT AND PAYMENT**

1.0 SCOPE OF WORK

The work under this section consists of supplying, installing, testing and commissioning of all material and services for provision of Structured Cabling Network as specified herein, as shown on Bidding Drawings and stated in the Bill of Quantities.

The Contractor shall discuss the Structured Cabling Layout with the Engineer and co-ordinate at site with other services for exact route, location and position of the system.

The Structured Cabling Network work with accessories shall also comply with the General Specifications, Section – 8001 and with other relevant provisions of the Bidding Document.

2.0 GENERAL

To ensure optimum performance, components of the structured cabling shall be sourced from the one manufacturer. This shall eliminate potential problems such as electrical and mechanical mismatch between different manufacturers.

Structured Cabling shall be covered under the manufacturers Certified Installation Program and installed by Certified Installation Company. Under this arrangement, the supply of components from the one manufacturer will facilitate the manufacturers Certification requirements of sole supply.

The Structured Cabling Network shall support the following systems, but not be limited to these systems.

3.0 APPLICABLE STANDARDS AND CODES

The following standards and all “normative addendums” shall be applicable to this document and must be adhered to for any installation work performed.

EIA/TIA 568-A	Commercial Building Telecommunications Cabling Standard.
EIA/TIA 569-A	Commercial Building Telecommunications Cabling Standard Pathways and Spaces.
TSB 67	Transmission Performance Specifications for Field-Testing of Unshielded Twisted-Pair Cabling Systems.
IEEE 802.3	Wire Speed Performances
IEEE 802.1Q	VLAN

All copper/optical fiber cabling, components and connecting hardware shall be in accordance with latest revision of ISO/IEC 11801, ISO/IEC/TR3 8802-1,

ISO/IEC/8802-3, ISO/IEC 61935-1, IEC 60364-1, IEC 60950, EN50173, EN50174-1, EN50174-2, and EIA/TIA TSB 72/73.

4.0 MATERIALS

4.1 Category – 6 UTP Cable

The horizontal cabling shall be Category – 6 UTP, 4 pair cable with gigabit support and specified up to 250MHz. The cable employed shall have excellent electrical characteristics and shall possess low weight, have slim design and shall be non corrosive (to IEC 60754-2), low smoke (to IEC61034), and flame retardant (to IEC 60332-3) and DIN VDE 0472, Part 804, test type C). The cable shall meet the requirements for EN 55022 Class B emission and EN 55024 immunity to be compliant with standards of electromagnetic compatibility and shall comply with following specifications:

Electrical Specification

- DC Resistance - < 200 milli Ohms
- DC Resistance Imbalance - < 50 milli Ohms
- Insulation Resistance - > 500 Mega Ohms min
- Wiring Sequence - TIA/EIA 568 A+B
- Delay Skew - < 1.25 nanoseconds

Mechanical Specification

- Diameter of Copper - AWG 23
- Wire Insulation - Zero Halogen foam - skin Material
- Sheath Material - Zero Halogen, Flame Retardant
- Deployment Area - Dry and Damp Rooms
- Temperature Range (moving) - 0 °C to +50 °C
- Operating Temperature - -20 °C to +60 °C
- Min. Bend Radius for Single Flexure - ≥ 40 mm
- Min. Bend Radius during Installation - ≥ 60 mm

4.2 Category – 6 RJ-45 Outlets

The horizontal cabling shall be terminated on RJ-45 outlets on white plastic wall plate. The category-6 outlets shall have provision of two outlets and shall accommodate one or two inserts (as per BOQ). To maintain security, the module shall not be removable from the front of wall plate. The RJ-45 outlets shall be protected by a spring-loaded

shutter which will cover the outlet when not in use. Outlets shall comply with following specifications:

Electrical Specification

- DC Resistance - < 200 milli Ohms
- DC Resistance Imbalance - < 50 milli Ohms
- Insulation Resistance - > 500 Mega Ohms min
- Wiring Sequence - TIA/EIA 568 A+B
- Delay Skew - < 1.25 nanoseconds

Mechanical Specification

Jack Contact

- Material of RJ45 pins - Copper alloy
- Plating of RJ45 pins - Gold plate 1.4 µm
- Operating Life (number of RJ45 Insertions) - 1500
- Plastic Housing (material type) - Polycarbonate (VO)

IDC Block

- Material of metal terminals - Copper alloy
- Wire Accommodation (diameter range) - AWG 22-24
- Tool Accommodation (required or not) - NO
- 7 Gas Tight IDC Cable Termination (yes/no) YES
- Plastic Housing (material type) - Polycarbonate (VO)
- Operating Life (number of re-terminations) up to 5

4.3 Copper Patch Cord:

The patch cords should be designed for applications up to 250 MHz and provides transmission performance meeting Category 6 specifications. Cables should be low skew products. I.e. the difference in propagation delay between the individual pairs is very low. Additional features are the slim design and low weight of the cables. The cable should meet or exceed the requirements for EN 55022 Class B emission and EN 55024 immunity allowing for networks to be built that are compliant with the standards on electromagnetic compatibility.

4.4 Copper Patch Panel:

Industry Standard 19" Patch panel capable of accommodating 24/48 No. Category – 6 UTP outlets. The patch panel should be modular having 1U height with integral strain relief. Front panel of patch panel should be made of high-grade steel.

4.5 **Racks**

All racks, shall be 19 inch racking products. In all cases the backbone cabling sub-system shall be terminated into rack mounted panels and presented as MTRJ fibre connectors. The rack shall have Plexiglas door with pivoted handle and square key. Earthing point, multi socket strip for supplying power to the active components of data network and roof ventilator shall be provided in each rack.

Cable management shall be provided with manageable patching facility. Horizontal management side rings shall provide an environment for ongoing maintenance of all future patching and enable move and changes to be handled easily.

The Contractor shall be responsible for all records and labeling of the rack mounted panels, both fibre and UTP, to the convention provided by the Client.

4.6 **Cable Management**

Cable management facilities within each rack at the Wiring Closet Sub-system are a mandatory requirement.

The cable management channels shall be made up of power coated mild steel 19-inch rack mount panels with integrated "fingers" in which to route the patch leads. The horizontal channel formed by these fingers shall be enclosed by a snap-on ABS plastic cover at both ends of panel separate ABS plastic rings shall be mounted using the rack mount bolts of the panel to create a vertical ring run up the rack. These rings shall be sufficiently large enough to comfortably accommodate in excess of 50 patch leads, yet narrow enough not to overhang the width of the rack or obscure the horizontal ring run segment.

The cable management panels should be mounted on the patching facility between active and passive rows of RJ45 ports. In this way, patch leads from every RJ 45 patch panels port are directed to the cable management panels above or below the outlet, so that at no time even when fully populated, outlets are obscured by patch leads. Such a layout shall ensure the patching facility, when cable management is properly utilized, does not go out of control and can be efficiently utilized for adds, moves and changes over the life of the Structured Cabling System. The plastic rings shall be sufficiently large enough to comfortably accommodate in excess of fifty (50) patch leads at any time.

In view of the dynamic nature of the patching facility, the "fingers" of the cable management panels shall be made of mild steel and integral to the metal panel, so that excessive force on the patch leads do not deform the channel formed within the "fingers". The cable management panel shall

be supplied with a snap on cover to discretely conceal the patch leads when the patching facility is static.

To facilitate effective patching during the life of the Structured Cabling System, the rack shall be laid out for minimal clutter and the shortest reasonable route for patch cords.

5.0 INSTALLATION

All cable installations shall be completed according to the local regulatory board and conform to EIA/TIA 568-A and shall comply with the following criteria:

5.1 UTP Cable Installation

Cables shall be installed in already laid steel cable trunking (within suspended ceilings) suitably anchored to the building structure, and in conduit in floor and partitions (concealed). Cables shall be secured every 600mm using hook and loop fastening ties. Due care shall be taken to not over tighten ties and place undue strain on the cabling infrastructure.

Cables shall be bundled to a maximum of 24 UTP cables and each bundle individually supported within the cable trunking.

Bend radius shall be limited to 10 times the cable diameter (UTP).

During the installation of a UTP cable (maximum 90 metres) the pull distance should not exceed 30 metres at any one time.

6.0 TESTING AND COMMISSIONING

The following tests shall be carried out and the results shall be documented and maintained to form part of the "AS BUILT" drawings.

1. Test all of the STP copper cable installation for termination and twisted pair integrity, including continuity, polarity, pin-assignment and colour codes.
2. Perform visual inspections to ensure that each pair of wires remain twisted as close as possible to the termination point, to maintain the impedance and minimize attenuation losses.
3. Test that the STP cable pairs comply with the Specification using measuring device for Near End Cross-talk and Signal Attenuation complying with EIA/TIA 568-A.

The documentation required at the completion of the installation phases shall contain all of the following information, together with any other information the installer has acquired during the installation.

1. "As-Built" documentation, showing total cabling and connection installed, utilizing floor space plans and cable record sheets. This documentation shall show all cables and outlets incorporating the full numbering and marking convention supplied.
2. All test results and certification information, identified by cable, connection and numbering convention, necessary for all Optical Fibre and copper cables.

All components of the Structured Cabling should be sourced from one manufacturer to ensure minimal impedance mismatch and best possible NEXT performance and to guarantee the Category-6 performance from end to end.

The Structured Cabling System should operate without introducing or being affected by electromagnetic radiation from other sources. Maintaining segregation from other services or screenings are to be ensured to achieve acceptable immunity.

7.0 MEASUREMENT AND PAYMENT

7.1 General

The Contractor's bid amount against each Bill of Quantities item as given below shall include supply, installation, testing, commissioning and completion for all work specified herein and/or as shown on the Bidding Drawings related to the item.

7.2 Backbone Cabling

7.2.1 Measurement:

Measurement shall be made for the total running meter of backbone UTP cable acceptably supplied and installed by the Contractor.

7.3.2 Payment:

Payment shall be made for the total running meter measured as provided above at the Contract unit price each and shall constitute full compensation for supply, installing, testing and commissioning of the backbone UTP cable including fibre management system and all accessories.

7.3 Conduit and Pipes

7.3.1 Measurement:

Measurement shall be made for the total running meter of conduit and pipes acceptably supplied and installed by the Contractor.

7.3.2 Payment: Payment shall be made for the total running meter measured as provided above at the Contract unit price each and shall constitute full compensation for supply, installing, pouring and excavation of the conduit and pipes

7.4 RJ 45 Socket Outlet

7.4.1 Measurement:

Measurement shall be made for the total number of RJ 45 socket outlet acceptably supplied and installed by the Contractor as a complete unit.

7.4.2 Payment:

Payment shall be made for number of units measured as provided above at the contract unit price each and shall constitute full compensation for supplying, installing and completion of the RJ 45 socket outlet including all civil works and other accessories.

7.5 Patch Panels/Cable Management/Racks

7.5.1 Measurement:

Measurement shall be made for the total number of each patch panel/cable management/racks acceptably supplied and installed by the Contractor as a complete unit.

7.5.2 Payment:

Payment shall be made for number of unit measured as provided above at the contract unit prices each and shall constitute full compensation for supplying, installing, testing, commissioning and completion of the patch panel/cable management/racks including interconnecting cable trays between racks and all accessories.

7.6 **Wiring of RJ 45 Socket Outlets**

7.6.1 Measurement:

Measurement shall be made for the total number of wiring of RJ 45 socket outlet acceptably carried out by the Contractor as a complete unit.

7.6.2 Payment:

Payment shall be made for the total no. of units measured, as provided above at the Contract unit prices each and shall constitute for supplying, installing connecting, testing, commissioning and completion of the wiring between RJ 45 socket outlet and patch panel and between patch panels including required pair of multi-core data cable, appropriate size conduit and all accessories.

*** End of Section 8312 ***

SECTION - 8335

CLOSED CIRCUIT TELEVISION SYSTEM (CCTV)

- 1.0 SCOPE OF WORK**
- 2.0 GENERAL**
- 3.0 APPLICABLE STANDARDS AND CODES**
- 4.0 EQUIPMENT**
- 5.0 VIDEO SURVEILLANCE APPLICATION SOFTWARE**
- 6.0 INSTALLATION**
- 7.0 TRAINING**
- 8.0 MEASUREMENT AND PAYMENT**

1.0 SCOPE OF WORK

The work under this section consists of supplying, installing, testing, connecting and commissioning of all materials and services of the complete CCTV system as specified herein, or as given in the Bidding Drawings and stated in the Bill of Quantities.

The Contractor shall discuss the CCTV layout with the Engineer and co-ordinate at the site with other services for exact route, location and position of the electrical lines and equipment.

The CCTV system with accessories shall also comply with the General specifications for Electrical Works, Section - 8001 and with other relevant provisions of the Bidding Documents.

2.0 GENERAL

The CCTV System shall be used for general surveillance. All the active items of the CCTV System shall be listed as a product of a single manufacturer.

Proposed CCTV system shall be an open standard based integrated system with IP network centric functional and management architecture aimed at providing high-speed manual/automatic operation for best performance.

System shall use video signals from various type of indoor/outdoor CCD colours cameras installed at different locations, process them for viewing on workstations/monitors at Fire Alarm/Security Room and simultaneously record all the cameras after compression using MPEG 4 or better standard. Joystick or Mouse-Keyboard controllers shall be used for Pan, Tilt, Zoom and other functions of desired cameras.

System shall have combination of Digital CCD Colour Video Cameras with individual IP address, analogue CCD Colour Video Cameras with Fixed or P/T/Z Lens, Encoders/ Decoders, Network Video Reorders (NVR/CAMERA SERVER), Network Attached Storage (NAS) / Riad backup device for recording, Application Software, Colour Video Monitors, Keyboards with Joystick Controllers / Mouse-Keyboard, software based Video Matrix Switcher, Workstation for System Administration / Management / Maintenance etc.

The NVR / Camera Server can be embedded type or server based. However the NVR / Camera Server Software shall run on common off the shelf available servers (Camera Server & Database Server). Each NVR shall be able to handle 16 or more cameras.

Network Video Recorder shall offer both video stream management and video stream storage management. Recording frame rate & resolution in respect of individual channel shall be programmable.

System should ensure that once recorded, the video cannot be altered, ensuring the audit trail is intact for evidential purposes.

System shall provide sufficient storage of all the camera recordings for a period of 30 days or more @ 30 FPS, at 4 CIF or better quality using necessary compression techniques for all cameras (extended capacity of cameras i.e. present capacity + 25%).

System shall use a combination of IP enable cameras & analogue CCD cameras with external encoder. The video shall be compressed using MPEG-4 or better standard and streamed over the IP network.

Encoders shall digitize analog video, compress the digital video using various compression algorithms (MPEG-4 or better standard), and transmit the compressed digital video over packet-based IP network. Encoders shall have less than 200 ms of latency and shall support dual stream – MPEG 4.

The recording resolution and frame rate for each camera shall be user programmable.

The Area under surveillance shall be monitored and controlled from Fire Alarm/Security Room(s) through workstations and Joystick controllers.

Surveillance CCTV System shall operate on 230 V, 50 Hz single phase power supply. Power for all the equipment will be conditioned using on-line UPS with minimum 30 minutes or more back up. If any equipment operates on any voltage other than the supply voltage and supply frequency, necessary conversion/correction device for supply shall be supplied along with the equipment.

All the control equipments e.g. servers, NVR/CAMERA SERVER, NAS/Raid backup device, decoders etc. shall be provided in standard racks.

All the indoor cameras & control equipment shall be suitable for operation from 10°C to 40°C and relative humidity up to 80% non-condensing. Cameras & other equipment, meant for outdoor installations, shall be suitable to work from (-) 10°C to (+) 50°C with RH upto 90% non-condensing. This temperature range may be achieved with or without heater.

Camera with external encoder or IP Cameras shall be used for image capture. Indoor cameras shall be either with fixed focal length lens or with Pan/Tilt & Zoom lens as per site requirement. All outdoor cameras shall be Day/Night cameras.

Housing of cameras meant for indoor use shall be of IP 42 rating whereas outdoor camera housing shall be of IP 66 or better rating. These must be integrated by the camera manufacturer.

System must provide built-in facility of watermarking or digital certificate to ensure tamperproof recording so that these can be used as evidence at a later date, if so desired. The recording shall support audit trail feature.

All camera recordings shall have Camera ID & location/area of recording as well as date/time stamp. Camera ID, Location/Area of recording & date/time shall be programmable by the system administrator with User ID & Password.

Facility of camera recording in CIF, 2CIF, 4CIF as well as in any combination i.e. any camera can be recorded in any quality – selective or group of cameras must be available in the system.

System to have facility of additional camera installation beyond the originally planned capacity.

In order to optimize the memory, while recording, video shall be compressed using MPEG-4 or better standard and streamed over the IP network. Once on the network, video can be viewed on a control room workstation or on analog monitor using a hardware decoder (MPEG-4/compatible standard Receiver) and shall be recorded on NVR/CAMERA SERVER and shall be backed up on NAS/RAID Backup device.

System shall be triplex i.e. it should provide facility of Viewing, Recording & Replay simultaneously.

The offered system shall have facility to export the desired portion of clipping (from a desired date/time to another desired date/time) on CD or DVD. Viewing of this recording shall be possible on standard PC using standard software like windows media player etc.

PTZ Cameras shall have 64 or more pre-defined positions to be selected through suitable input alarm.

Redundancy /Fail-over feature is required i.e. in case of failure of an NVR/CAMERA SERVER the relevant cameras shall automatically switch over to the redundant NVR/CAMERA SERVER.

System shall have provision of WAN connectivity for remote monitoring.

3.0 APPLICABLE STANDARDS AND CODES

The following standards and codes shall be applicable for the material covered within the scope of the section.

IEC 801 – 2	Electrostatic discharge
IEC 801 – 3	Radiated Electro magnetic interference
IEC 801 – 4	Voltage transients

Install all the signal transmission components in accordance with the relevant standard ANSI Locate all surge protection within are metre of building entrance:

- Dust and rain resistance IP66 for outdoor cameras.
- Salt mist According to IEC 68-2-11 (for outdoor cameras)
- Vibration According to IEC 68-2-6
- Bump test According to IEC 68-3

4.0 EQUIPMENT

4.1 Fixed Colour Dome/Box Camera Varifocal

Image Device	1/3" or 1/4" CMOS Sensor
Number of Pixels Minimum	720 x 576
Scanning System	PAL
Resolution	480 TV Lines or better
Min Illumination	1 Lux at F1.2
S/N Ratio	> = 48 dB
Electronic Shutter	AUTO
Lens	Built-in Varifocal lens. Auto Iris, lens F=4-9 mm (approx.)
Backlight compensation	Required
Power Supply	As per OEM's design

4.2 Colour Video Dome Camera with PTZ

Colour video dome camera with PTZ shall have following technical:

Image Device	Interline transfer 1/2.8" or better format CMOS Sensor
Focal length	4 mm to 72 mm or better (for Artificial Intelligence Cameras with better focal length i.e; 3.5 mm to 91 mm to be used)
Optical zoom (for indoor camera)	18 x or better
Optical zoom (for outdoor camera)	26 x or better

Number of Pixels	720 x 576
Scanning System	PAL
Resolution	480 TVL or better
Illumination (for indoor camera)	1.0 Lux (Color), 0.1 Lux (B/W) or better
Illumination (for outdoor camera)	1.0 Lux (Color), 0.05 Lux (B/W) or better
Pan Travel	360° Continuous
Tilt Travel	0 – 90°
Manual Tilt Speed	0.5°/SEC to 90°/SEC
Manual Pan Speed	0.5°/SEC to 90°/SEC
Preset Tilt Speed	0.5°/SEC to 90°/SEC
Preset Pan Speed	0.5°/SEC to 300°/SEC
Preset positions	Min. 64
Iris Control	Auto
Focus	Auto
Back Light	Required with black masking or other suitable technology compensation
White balance	Auto
Electronic shutter	Auto
S/N ratio	>=48 dB
Power supply	As per OEM's design, however generally AC 230V @ 50 Hz/12V or 24V AC Rectifier and SMPS if DC supply.

4.3 **MPEG-4 Encoder (Hardware Based)**

The encoder shall be built on embedded processor and real time operating system. The encoder should have convert Analog Composite/S-Video input into good quality digital stream on real time basis and shall be able

to transmit as Unicast/Multicast IP packet with low latency (less than 200 m Sec.) for live viewing as well as for recording.

The video resolution should be configurable at either of 4 CIF, 2 CIF, CIF @ 30 fps or at lower frame rate per camera, user selectable.

The encoder should generate MPEG-4 video stream complaint with ISO/IEC 14496 standard. The encoder should be interchangeable with any standard encoder of any other make, which generates MPEG-4 video stream complaint with ISO/IEC 14496 standard.

The Encoder should have the following specifications or should match with the requirement:

Format	PAL color, B/W, composite, 30 fps, 2:1 interlaced
Resolution (HxV pixels)	4 CIF 704 x 576, 2 CIF, CIF, QCIF
Frame Rate	30 fps (PAL) and lower
Encoding	MPEG-4 complaint with ISO/IEC 14496 standard
Video Parameters selectable	Brightness, contrast, hue, sharpness and sizing
Video Latency	Less than 200 m Sec
Connectors connectors	BNC for composite Video for input, suitable for Power, Alarm in, and Alarm out, RJ-45 for Ethernet 10/100 Base-T output
IP Address	Static IP Address or as per system requirement
MPEG-4 standard	Complaint with ISO/IEC 14496
IP Packets	Unicast and Multicast
POE	Complaint
Power supply	As per OEM's design

4.4 **Workstation**

CPU	Latest Generation with optimum specs
Mother Board	Intel Original Mother Board

Memory	3 GB DDR RAM
Hard Drive	1TB or more
Keyboards	PS / 2 Keyboard
Mouse	Optical Mouse with Scroll
Video Card	In Built 2 Nos for connecting 2 monitors
RAID	Supported
Network Adapter (NIC)	Integrated 10/100/1000 Base-T
Sound Card	In-Built
DVD Writer	DVD+16x – 16x, RW + 8x – 6x, CDW 48x, Blu Ray
Monitor	32” TFT Monitor
USB 2.0 or fire wire card	2 Nos. at front panel
Operating System	MS Windows OS or Linux (Latest versions) at the time of Bidding
Anti Virus Software	Latest software at the time of Bidding

4.5 **NVR/Camera/Database Server**

CPU	Latest Generation with optimum specs
Memory	2 GB DDR RAM
Hard Drives	As per video storage with RAID 5 Support
DVD Writer Ray	External DVD+16x - 16x, RW+ 8x - 6x, CDW 48x, Blu
Network Adapter (NIC)	Dual TCP/IP Integrated 10/100/1000 Base-T
Sound Card	In-Built
Graphic Card	Super VGA non-interlaced graphic card capable of 1024 x 768 pixel resolution and 65K colors (or true color) with 4 MB video memory or better
Recording Speed	30 fps / channel (minimum 32 channel)

USB 2.0 or fire wall	2 Nos. at front panel
Keyboards	PS / 2 Keyboard
Mouse	Optical Mouse with Scroll
Monitors	19" TFT Monitor
Operating System	MS Windows OS or Linux (Latest versions) at the time of Bidding
Anti Virus Software	Latest software at the time of Bidding

4.6 Camera Housing & Mount

The camera mount should be:

- i) Of the same make as that of camera and suitable for the model number offered as specified by the manufacturer and should be an integrated unit.
- ii) Should be compact and indoor/outdoor types as required.
- iii) Should support the weight of Camera and accessories such as housing, pan & tilt head in any vertical or horizontal position etc.

4.7 Speed Dome Controller / PTZ Controller

Speed dome controller should have variable speed joystick, LCD display for programming and it should be able to control the speed dome for PAN/TILT/ZOOM.

4.8 Cables

Sr #	Connectivity	Cable Type
1	Camera to Video Encoder	Coaxial RG6/U/CAT6/Fibre Optic
2	Video Encoder to Switch in Control Room	UTP CAT6/Fibre Optic
3	Switch to Video Wall Switches	UTP CAT6/Fibre Optic
4	From Switches to NAS Box	Fibre Optic
5	Hardware Decoder to Monitor	Composite Signal Cable

4.9 LCD Display

40" Color TFT LCD display shall have following minimum technical specification.

Resolution	500 TVL: 1280x1024 pixels
Display Mode	VGA/SVGA/XGA
Luminance	250 cd/square meter
Power Source	230 VAC/50 Hz

5.0 VIDEO SURVEILLANCE APPLICATION SOFTWARE

The software shall operate on open architecture for integration with perimeter safety, access control, PA and fire / safety systems based on open standards.

Digital video surveillance control software should be capable to display and manage the entire surveillance system. It should be capable of supporting variety of device such as cameras, video encoders, video decoders, PTZ controller, NVR, NAS boxes/Raid backup device etc.

The software should have inbuilt facility to store configuration of encoders/decoders and cameras.

The software should support flexible 1/2/4 windows split screen display mode or scroll mode on the PC monitor or on preview monitor as per site requirement.

The software should be able to control all cameras i.e. PTZ control, Iris control, auto/manual focus and color balance of camera, selection of presets, video tour selection etc.

There must be a single encoder for each camera.

The software is required to generate reports of stored device configuration. The control software is required to provide alarm and alarm log. The log shall be able to be achieved, printed and displayed using a device filter, a device group filter and/or a time window.

The software should have user authority configurable on per device or per device group basis. The user shall have the facility to request the access of any camera and can control the camera for a reservation period. Control of camera is released after the reservation period.

The system shall provide user activity log (audit trail) with user id, time stamp and action performed etc.

The administrator should be able to add, edit & delete users with rights. It shall be possible to view ability/rights of each user or the cameras which can be viewed & controlled as per the permission assigned by the administrator.

The users should be on a hierarchical basis as assigned by the administrator. The higher priority person can take control of cameras, which are already being controlled by a lower priority user. There should be minimum 3 hierarchical levels of security for providing user level log in.

It should have recording modes viz. continuous, manual or programmed modes on date, time and camera-wise. All modes should be disabled and enabled using schedule configuration. It should be possible to search and replay the recorded images on date, time and camera-wise. It should provide on screen controls for remote operation of PTZ cameras. It should have the facility for schedule recording. Different recording speeds (fps) and resolution for each recording mode for each camera should be possible.

It should provide programmable motion detection and recording, to be defined area-wise. System must be able to support video motion detection algorithms to detect and track objects, learn the scene, adapt to a changing outdoor environment, ignore environmental changes including rain, hail, wind, swaying trees and gradual light changes.

The settings shall be individually configurable for each alarm and each camera pre-record duration. This shall allow the camera server to capture video prior to the alarm/event shall be selectable from a list of values ranging between 0 seconds and 5 minutes.

The software for clients should also be working on a browser based system for remote users. This will allow any authorized user to display the video of any desired camera on the monitor with full PTZ and associated controls.

Retrieval: The CCTV application should allow retrieval of data instantaneously or any data/time interval chosen through search functionality of the application software. In case data is older than 3 days and available, the retrieval should be possible. The system should be allow for backup of specific data on any drives like CD/DVD/Blu ray Recorders or any other device in a format which can be replayed through a standard PC based software. Log of any such activity should be maintained by the system which can be audited at a later date.

Backup: Online backup should be maintained to protect against storage failure.

Storage: Data storage should be at a central location in the airport. The capacity of the storage should be equal to 30 days of recording of all cameras at 30 fps/4 CIF. The system should follow FIFO on recording.

Artificial Intelligence: It shall have image tracking facility. If any object is found to be stationary for a pre-defined period the system shall track the event and alert the operator. This facility shall be provided on select cameras at entry point, check-in counters, X-Ray BIS points, SHA and as defined by the Bidder. The system must have the features for identifying tail-gating, vehicle detection features, unattended baggage identification, queuing analysis, external text insertion feature and intruder detection.

6.0 INSTALLATION

Installation of CCTV System shall be done in strict accordance with the manufacturer's recommendations.

7.0 TRAINING

A training session shall be presented by a fully qualified, trained representative of the equipment manufacturer/supplier who is thoroughly knowledgeable of the specific installation. The training shall be given to personnel responsible for operation and maintenance of the system.

8.0 MEASUREMENT AND PAYMENT

8.1 General

The Contractor bid amount, against each Bill of Quantities item as given below, shall include design, supply, installation, testing, commissioning and completion for all work specified herein and / or as shown on the Bid Drawing Drawings related to the item.

8.2 Cameras / Lenses and Displays

8.2.1 Measurement:

Measurement shall be made for the total number of cameras/lenses and displays with accessories acceptably supplied and installed by the Contractor as a complete unit.

8.2.2 Payment:

Payment shall be made for the number of units measured as provided above at the Contractor unit price and shall constitute full compensation for supplying, installing connecting, testing and commissioning of the cameras/lenses and display including all mounting arrangement/racks, etc. and all accessories.

8.3 NVR / Controller

8.3.1 Measurement:

Measurement shall be made for the NVR/Controller acceptably supplied and installed by the Contractor as a complete job.

8.3.2 Payment:

Payment shall be made for the number of job measured as provided above at the contract unit price and shall constitute full

compensation for supplying, installing and completion of the NVR/Controller including all control equipment for operation and control of system, mounting racks and interconnections etc.

8.4 **Cable/Conduit**

8.4.1 Measurement:

Measurement shall be made for the cabling including conduiting for cameras acceptably supplied and installed by the Contractor as complete job.

8.4.2 Payment:

Payment shall be made for the total job measured as provided above at the contract unit price and shall constitute full compensation for supplying, installing, pouring and excavation of cabling including all accessories related to the items.

8.5 **Operator Console**

8.5.1 Measurement:

Measurement shall be made for the CCTV System Operator Console including chair acceptably supplied and installed by the Contractor as a complete job.

8.5.2 Payment:

Payment shall be made for the complete job measured as provided above at the contract unit price and shall constitute full compensation for supplying and installing of Console and all accessories.

*** End of Section 8335 ***

PLUMBING WORKS

SECTION - 5100

PLUMBING

- 1. SCOPE**
- 2. APPLICABLE STANDARDS**
- 3. SUBMITTALS AND SHOP DRAWINGS**
- 4. MATERIAL AND EQUIPMENT**
- 5. EXECUTION**
- 6. TESTING AND COMMISSIONING**
- 7. MEASUREMENT AND PAYMENT**

1. SCOPE

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

- I) Cold and Hot Water Supply
- ii) Building Drainage
- iii) Rain Water Drainage

All the above named systems shall be completed in all respects including extension of these internal systems upto the specified limits outside the building as indicated on the drawings.

2. APPLICABLE STANDARDS

G. I. Pipes	EN-10255 (BS- 1387 (1985)
Polypropylene Random (PPR) pipes	DIN 8077-78
C. I. Pipes	BS- 416 & 2494
uPVC Pipes (Building)	ISO- 3633 & BS- 4514/ 5255.
uPVC Pipes (Soundproof)	DIN EN 12056
uPVC Pipes (External)	BS-5481/ BS-4660 (EN-1401)

3. SUBMITTALS & SHOP DRAWINGS

All the materials and equipment shall be of the specifications mentioned herein and the Contractor shall submit the sample, necessary catalogues, sketches, the name of manufacturer and guarantee if necessary, before installation. The system shall be installed after the Engineer approves it. All material and equipment shall be new and unused.

It is specifically intended and must be agreed to by each Contractor submitting a bid, that any material or labor which is usually furnished as a part of such equipment and which is necessary for its proper completion and best operation shall be furnished as a part of this Contract without any additional cost whether or not shown in detail on the drawings or described in detail, in the specifications.

Approval of material and equipment by the Engineer shall not absolve the Contractor of the responsibility of furnishing the same of proper size, quantity, quality and all performance characteristics to efficiently fulfill the requirements and intent of the Contract Documents.

Prior to commencement of works on site and at least 3 weeks in advance of all the drawing being required for actual execution the Contractor shall submit on larger scale as approved by Engineer, shop drawings in triplicate for approval to the Engineer. The Engineer shall review the drawing and (i) approve the drawing or, (ii) approve the drawing with comments or, (iii) disapproved the drawings with comments for rectification/revision of the drawing and resubmit 3 copies to the Consultant for approval. On a drawing being approved, the Contractor shall submit 6 copies for formal approval and distribution to relevant offices.

All drawings shall have plan and section and with sufficient details to clearly reflect the installation of the system. All material specifications shall be provided on the drawings. All information required for preparing suitable foundation, for providing suitable access to

the system, for making openings in building structure, for coordination with electrical, air-conditioning and other designs etc., shall be clearly provided.

Installation shall not be allowed to commence unless approved shop drawings are in possession of the Contractor, for which purpose shop drawings shall be submitted by the Contractor to the Engineer sufficiently in advance of actual requirements to allow for ample time in checking and approval and no claim for extension of the contract time will be considered by reason of the Contractor's failure to submit the drawings on time.

Each shop drawing submitted by the Contractor shall include a certificate by the Contractor that all related conditions on site relevant to that particular installation have been checked and that no conflict exists.

Any expenses resulting from an error mistake or omission in or delay in delivery of the drawings and information mentioned above shall be borne by the Contractor.

Drawings approved shall not be departed from except on the instructions of the Engineer.

The approval by the Engineer for any submitted data, working drawings, performance curves, test certificates for any items, arrangements and/or layout shall not relieve the Contractor from any responsibility regarding the performance of the Contract. Such approval shall not also relieve the Contractor from responsibility of any error in the submitted data and workings, brought to light at any time subsequent to any approvals.

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

4. MATERIAL & EQUIPMENT

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

The galvanized pipes shall be of medium grade and conform to British Standard Specifications 1387 for "Steel Tubes and Tubular suitable for screwing to BS 21 pipe threads".

All screwed tubes and sockets shall have BS pipes thread in accordance with BS 21. In order to prevent damage to the leading thread, the ends of the sockets shall be chamfered internally.

A complete and uniform adherent coating of zinc will be provided for galvanized pipes.

Every tube shall be tested at the manufacturer's works to a hydraulic test pressure of 4.90 MPa (710psi) and shall be maintained at the test pressure sufficiently long for proof and inspection.

Tubes which are bundled shall be secured together by rope or soft iron or other suitable material.

The threads of all tubes shall be effectively covered with a good quality grease or other suitable compound, and each tube above 50 mm nominal bore shall have a protecting ring affixed to the unsocketed screwed end.

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

4.2 POLYPROPYLENE RANDOM (PPR) PIPES AND FITTINGS

Polypropylene Random Pipes and fittings shall conform to the following standard

DIN	8077-8078	Resistible to all chemical elements
DIN	16961	Smooth inner surface
DIN	19560	Usability for hot water all levels
DIN	4279	Durable to inner pressure
DIN	16962	Conforms to connections by welding process

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

The cast iron pipe shall conform to British Standard Specifications No.416 for "Cast Iron spigot and socket soil, waste and vent pipes and fittings with spigot and socket or hubless ends. The joint shall be lead caulked or elastomeric (Rubber rings) to BS- 2494.

Cast iron pipes shall be centrifugally (SPUN) cast.

The quality of material shall be according to B.S.S. No.1452 for Grade 10.

The contractor shall supply coated pipes and fittings. The coating composition shall be of tar basis or a mixture of natural bitumen with a suitable hardener and natural asphalt. The coatings shall be smooth, tenacious, sufficiently hard, not to flow when exposed to a temperature of 63 Degrees Celsius and not so brittle at zero degrees Celsius that it chips soft when scribed lightly with the point of a pen knife.

Every pipe shall be tested at the manufacturer's work to a hydraulic test pressure of 0.07 MPa (10psi). Every pipe and fitting shall ring clearly when tested for soundness by being struck all over with a light hammer.

UPVC Pipes

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

PIPES

- a. There are two types of pipes and fittings, type A and type B, as per ISO 3633 for drainage systems. Only type B shall be used for soil, waste and venting systems.
- b. As per BS4514/5255, sanitary pipes and fittings shall be class "A" wall thickness 3.2mm.

FITTINGS

All fittings shall be compatible with the pipe material as recommended by the pipe manufacturer.

However, there are two types of fittings available as per ISO 3633:

- uPVC fittings with Solvent Cement (SC) socket joint conforming to ISO 3633:1991.
- uPVC fittings with rubber ring socket joint conforming to DIN 19560, which is compatible with ISO 3633/PS 3214.

RUBBER RINGS

The rubber rings may either be Synthetic or natural conforming to PS 1915:1987 & ISO 4633/1983 (E).

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

The pipes and fittings shall be tested mechanically and physically in accordance with the relevant Standards as and when directed by the Engineer, before and during installation.

4.4 PLUMBING FIXTURES

4.4.1 General Requirements

Materials shall conform to the latest referenced standard specifications and other provisions stipulated herein and shall be new and unused.

All fixtures shall be of the best quality and finish.

Prior to procurement of the materials, the Contractor shall be required to prepare and submit to the Engineer for his approval, a complete schedule of materials to be used in the works together with a list of the names and addresses of the manufacturers and the trade names of the materials. The schedule shall include diagrams, drawings and such other technical data as may be required by the Engineer to satisfy himself as to the suitability, durability, quality and usefulness of the material to be purchased.

Approval of the schedule shall not be construed as authorizing any deviations from the specifications unless the attention of the Engineer has been invited to the specific changes. If the material or equipment offered under this provision is, in the opinion of the Engineer, equal to or better than specified, it will be given consideration.

Plumbing fixtures shall have smooth impervious surfaces, be free from defects and concealed fouling surface. They shall be true to line, angles, curves and colour etc. Normally they shall be of local make and of the best quality available, provided.

All taps and cocks to be installed with plumbing fixtures shall be chrome plated (CP) and shall be of appropriate class to work without damage or leakage on the specified pressure of potable water system, which is 0.88 MPa (128 psi). The taps and cocks shall be of the best quality locally manufactured.

When any fixture is provided with an overflow, the waste shall be so arranged that the standing water in the fixture cannot rise in the overflow when the stopper is closed or remain in the overflow when the fixture is empty.

Plumbing fixtures shall be installed in a manner to afford easy access for cleaning. The space between the fixture and the wall shall be closely fitted and pointed so that there is no chance for dirt or vermin to collect.

When practical, all pipes from fixtures shall be run to the nearest wall. where fixture comes in contact with wall and floors, the joint shall be watertight.

Wall hung fixtures shall be rigidly supported by metal supporting members so that no strain is transmitted to the connections. Flush tanks and similar appurtenances shall be secured by approved non-corrosive screws or bolts.

Fixtures shall be set level and in proper alignment with reference to adjacent walls. No water closet shall be set closer than 400 mm from its centre to any side wall. No urinal shall be set closer than 300 mm from its centre to any side wall or partition nor closer than 600 mm centre to centre. The supply lines or fittings for every plumbing fixture shall be so installed as to prevent backflow. All cuttings, making holes etc. and making it good shall be included in the work.

Other physical/chemical properties of the fixtures are as below:

S. No.	Physical/Chemical Properties	Pakistan Standards	European Standards
1	Water absorption	Less than 0.50%	Maximum 0.50%
2	Scratch Resistance	Maximum 5.5 MOH's scale	Maximum 5 MOH's scale
3	Resistance to Chemicals	Resistant to acids, alkalies, bases & other household cleaning chemicals	Resistant to chemicals.
4	Crazing Resistance	Crazing "NIL"	Crazing "NIL"
5	Warpage	Maximum 5.5-6mm	Maximum 6mm
6	Strength against bending	More than 700 kg/cm	450kg/cm - 700 kg/cm
7	Thermal shock	More than 10 cycles of thermal shock from hot to cold water 15°C-200°C	More than 2 cycles of thermal shock from hot to cold water 20°C-110°C
8	Durability	Permanently durable	Durable for ever

4.4.2 Wash Basins

Wash basin shall be vitreous China, best quality, local make of colour, size and type as approved by the Engineer. It shall be installed as a complete unit including 15 mm mixer for hot and cold water supply or CP brass faucet for cold water only, 15 mm stop-cocks, C.P brass chain with 32 mm rubber plug, C.P brass bottle trap for individual wash basin and C.P brass P trap for battery of wash basins as applicable, C.P brass strainer, heavy duty cast iron brackets with bolts, screws etc. approved water inlet connection pipe, waste pipe, jointing and sealing material, etc., with all other minor accessories required to complete the job in all respect.

4.4.3 Vanity Wash Basins & laboratory sink

Wash basin Vanity type & Laboratory Sink shall be vitreous China, best quality, local make of colour, size and type as approved by the Engineer. Other necessary fittings shall be same as described for above Wash basin.

4.4.4 Water Closets (European type)

European type water closet shall be best quality local make of colour, size and type as approved by the Engineer. It shall be installed as a complete unit including all accessories. Flush tank (13.5 liters) shall be of low level type - it shall be fitted with either single push button or double push button type. Trap shall be cast integral with pan. The seat

shall be of smooth non-combustible non-absorbent materials like Bakulite and of the open front type fixed to the pan with hinges. The fittings shall also include approved water inlet connection pipe, nuts bolts, 15mm dia stop cock etc. required for complete installation.

4.4.5 Water Closets (Orissa)

Squatting (Asian/Orissa) type water closet shall be vitreous China, best quality local make of colour, size and type approved by the Engineer. It shall be installed as a complete unit including, 15 mm stop cock, approved water inlet connection pipe, low level or high level Flush tank (13.5 liters), as required. All fittings shall be installed at low level, or high level as required including interconnecting flush piping. Foot rests, cast iron P trap, making joints, jointing and sealing materials, 15mm dia stop cock etc. with all other minor accessories for complete installation.

4.4.6 Kitchen Sinks

Kitchen sink shall be stainless steel of best quality local make of colour, and type as approved by the Engineer, single bowl or double bowl with integral drain board of at least 1000 x 500 mm size. It shall be installed as a complete unit with arrangement for both cold and hot water supply, 15 mm C.P. mixer for cold and hot water, approved water inlet connection C.P. brass strainer, waste outlet pipe, heavy duty cast iron brackets with bolts screws etc., jointing & sealing material, etc., with all other minor accessories required for complete installation.

4.4.7 Shower Tray

Shower trays shall be of glass reinforced polyester with hard glass finish best quality local make of colour and type as approved by the Engineer. It shall be installed as a complete unit including C.P. brass strainer, waste outlet pipe, bolts screws, jointing & sealing material, etc.

4.4.8 Shower Head

Shower head shall be installed on the wall at a suitable height including installation of chromium plated extension pipe, C.P. brass Mixer for cold & hot water etc. with all other minor accessories required for complete installation.

4.4.9 Bathtub

Bathtub shall be of the approved material such as Fiberglass, cast iron or acrylic. It shall be installed as a complete unit including chromium plated brass overflow sluice 1-1/4" in dia., chromium plated waste 1-1/2" dia. with chromium plated chain & rubber stopper (Plug), etc. complete in all respects for complete installation. Its colour shall match with that of other fixtures in the toilet.

4.4.10 Urinals

Urinals shall be vitreous China of approved make and size and of wall hung type either with integral water seal trap or with separate brass P-Trap. The complete unit shall be installed including 15mm Tee-stop cock, plastic water inlet/outlet connections, CP Flush Valve or 13.5 liters flushing cistern, heavy duty CI brackets, bolts, screws, and all internal accessories or; CP steel flush pipe. CP steel waste pipe, joints, jointing and sealing materials etc. with all other minor accessories.

4.5 MISCELLANEOUS ITEMS

4.5.1 Taps and Cocks

All taps and cocks shall be of brass, gun metal or other equally suitable corrosion resisting alloy conforming to BS 1010 and shall be best quality local make. The nominal size specified shall be the nominal bore of the seating. Washers for cold water cocks shall be of specially selected leather, rubber asbestos composition or other equally suitable material. Washers for hot water cocks shall be of good quality fiber, rubber - asbestos composition or other equally suitable material. Every tap/cock shall be tested, complete with its component parts, to a hydraulic pressure of at least 1.96 MPa (284.4 psi) During test it shall neither leak nor sweat.

4.5.2 Floor traps/drains

Floor traps/drains shall be of cast iron or uPVC or of other anti-corrosive material, compatible with the material of pipe. They shall have minimum water seal of 40 mm and shall be provided with removable metal/uPVC strainers. The traps shall be of self-clearing type. The open area of the strainer shall be greater than the cross section area of the drain line to which it connects. Floor traps shall be well set in position so that there is no leakage at the joint between trap and the floor.

4.5.3 Roof Drains

Roof drains shall be of bitumen coated cast iron, compatible with the material of pipe. They shall have strainers extending at least 15 mm above the roof surface immediately adjacent to them, when installed on flat part. Bottom of strainer shall be flush with the roof surface, when installed on vertical part. Strainer shall have an available inlet area, above roof level, of not less than 1-1/2 times the area of the down-pipe to which the drain is connected.

The connection between roof and roof drain shall be made watertight by the use of proper flashing material.

4.5.4 Cleanouts

Cleanout shall be of the same nominal size as that of the pipe on which it is installed. Cast Iron Cleanout shall consist of tapped heavy duty cast iron ferrule caulked into cast iron fitting and heavy duty brass tapered even plug. UPVC cleanout shall consist of either two 45° bends or one long radius bend both with a removable end cap and other necessary fittings/material for complete installation in floor Cleanouts shall be turned up through floors by long sweep fittings, wherever the space so permits. Top finish of cleanout shall be flush with the floor by means of finished metal plate secured in position and screwed firmly to the plug. Cleanout shall be so installed that there is a clearance of at least 300 mm for pipes less than 75 mm diameter and at least 457 mm for pipes of 75 mm and larger diameter, for the purpose of Roding. Pipe used with cleanout shall be measured and paid under pipe item. All other work of ferrule, plug, concrete work, frame and cover etc. shall be measured and paid under cleanout item.

4.5.5 Grease Trap/Interceptor

a. The grease trap shall be of stainless steel of specified capacity with cover, baffles and strainers to separate grease from water effectively. The grease trap shall be of approved make or equivalent and installed in the position as shown on drawings or as specified by the Engineer.

or

b. The grease interceptor shall be built in masonry or reinforced cement concrete as per relevant drawings including excavation, RCC class "C", steel reinforcement, PCC class "E", 15mm thick cement sand plaster in 1:3 c/s, 15mm thick C.I. trap & plate having holes (screen) 25mm c/c of standard diameter, 20mm G.I. pipe for lifting trap, inlet & outlet connections, 600x600 mm C.I. cover with frame, 25mm legs for supporting screen system, painting three coats to steel works with synthetic enamel paint, nuts, bolts etc. complete in all respects as desired by the engineer.

4.5.6 Glass Mirror

The glass mirror shall be of specified size, 5 mm thick, securely fixed on hard board packing and of best quality Belgium make. The mirror shall be fixed on wall as shown on the drawing or as directed by the Engineer. All accessories required for complete fixing of mirror on wall shall be included in Contractor's scope of work.

4.5.7 Towel Rail, Toilet Paper Holder, Soap Trays, Mirror Trays

The towel rail, toilet paper holder, soap trays & mirror trays shall be of best quality All accessories for complete installation of towel rail, toilet paper holder, soap tray and mirror tray shall be included in the Contractor's scope of work.

4.5.8 Gully Trap

Gully trap shall be of cast iron with specified size outlet. The inlet shall be provided with cast iron, medium duty grating. The open area of the grating shall be at least 1-1/2 times the area of the outlet. The trap shall be of P-Type with a minimum water seal of 50 mm. It shall be installed as a complete unit including all civil works as shown on relevant details and drawings.

4.5.9 Cast Iron Grating

Cast iron grating shall be of the specified size. The specified size shall mean the clear span. Cast iron grating shall be complete with frame. They shall be of Light/medium duty type to resist normal traffic loads, the casting shall be sound and free from all defects. The frame shall be set in place at the time of pouring of concrete. Openings in grating shall be in approved pattern.

4.5.10 Electric Water Cooler

Cabinet shall be of heavy gauge mild steel construction painted with non-corrosive paint from inside and with special hammer finish paint from outside.

Push button type water taps shall be chrome plated. Drain pot shall be made of hard plastic with stain-less steel tray. Back panel shall be easily

remove-able for cleaning and servicing top cover shall be of scratch proof Formica.

Water storage tank shall be either of stainless steel or copper alloy, tinned inside and outside with present insulation to maintain water temperature, with special arrangement for cleaning the tank.

Condensing unit shall be heavy duty, hermetically sealed with thermal overload protection for refrigerant F-12 and capillary expansion with valves for easy gas charging. Thermostat and other control necessary for proper functioning of the unit shall be provided. The thermostat shall control the temperature of cooled water between + 11 0C & + 20 0C.

4.5.11 WATER FILTERS

Water filters shall be installed on wall near the water coolers. They shall be of . Each filter shall have a crystal housing of a durable material. The flow rate shall be 2 to 6 gpm with a maximum pressure of 70psi and a temperature of 35°F to 100°F.

Stage 1:- Stage 1 shall use a "poly propylene Yarn Indepth Sediment filter cartridge", for removal of dust, rust, silt, scale and unseen suspended particles. It shall have a filtration rating of 5-micron.

Stage 2:- In this stage a "Granular Activated Carbon (GAC) cartridge" equipped with a post-filter of 1-micron is recommended, for removal of chemicals and unpleasant taste and odor.

Stage 3:- This stage must provide 30,000 MW.sec/sq.cm energy to guarantee 100% sterilization and ensure effective control of microbiological contamination.

4.5.12 Gas or Electric Water Heaters

Water heater shall be of automatic storage type Electric or Gas operated, including all necessary fittings for complete installation & operation. The heater shall be of best quality, local make as approved by the Engineer.

The working and test pressure of the heater to be of 6 bar and 10 bar respectively and shall deliver water at 150 °F. It shall be capable to reach the peak demand, storage capacity.

Heater shall be provided with following accessories.

- i) Thermostatic control
- ii) Temperature & pressure relief valve
High limit Control.

Other specifications of **Water Heater** are as given below:

Inner tank shall be extra heavy gauge anti-rust G.I. sheet metal to hold maximum inside water pressure. As an insulation, imported genuine glass wool shall be used to maintain the desired temperature that controls the lighting up of the burner. The outer body shall be made of requisite gauge M.S. sheet shaped into reinforced circumference. Flow and delivery pipes shall be of high quality G.I. pipes fabricated with heavy gauge anti-rust baffle plate. *The thermostat shall be of Robershaw (U.S.A) make or approved equivalent.* The burner shall be made of cast iron with drilled ports. It shall be easy to be detached. Special anti-rust-baked primer-heavy coated stoved enamel paint with high gloss automotive shine shall be used on sheet metal.

Standard type gas water heaters shall have following specs:

Capacity	Inner Tank	Outer body
8-15 gallons	G.I. sheet 14-16 swg	M.S sheet painted 22 swg
30 gallons	G.I. sheet 14-16 swg	M.S sheet painted 22 swg
50 gallons	G.I. sheet 14 swg	M.S sheet painted 22 swg
100 gallons	G.I. sheet 8-10 swg	M.S sheet painted 22 swg

5. EXECUTION

5.1 GENERAL

The Contractor shall be responsible for his work until its completion and final acceptance, and shall replace any of those that may be damaged, lost or stolen without any additional cost.

All openings left in floor for passage of lines of water supply, soil, waste, vent, etc. shall be covered and protected.

All open ends of pipes shall be properly plugged to prevent any foreign material from entering the pipe. Misuse of plumbing fixtures to be installed under this Contract is prohibited during the currency of the contract.

All metal fixture trimmings shall be thoroughly covered with non-corrosive grease which shall be maintained until all work is completed.

Upon the completion of work, all fixtures and trimmings shall be thoroughly cleaned, polished and left in first class condition.

Before erection, all pipes, valves, fittings, etc. shall be thoroughly cleaned of oil, grease or other material.

All special tools for proper operation and maintenance of the equipment provided under this Contract shall be delivered at no additional cost.

The Contractor shall allow in his bid for cost of all cutting, making holes and subsequent making it good to the desired finish as per approval of the Engineer. No separate payment shall be made for this item.

The Contractor shall allow in his bid for the cost of providing protective painting or coating as specified in the relevant sections and no claim shall be entertained for this item.

All pipes shall be properly installed as shown on the drawings and/or as directed by the Engineer, and shall be as straight as possible forming right angles and parallel lines with the walls and other pipelines. The position, gradients, alignment and inverts shall be as shown on the drawings and/or as directed in writing and set out by the Engineer.

The arrangement, positions and connections of pipe fittings and appurtenances shall be as shown on the drawings. The Engineer reserves the right to change the location etc. Special precautions shall be taken for the installation of concealed pipes as shown on the drawings and/or as required. Should it be necessary to correct piping so installed, the Contractor shall be held liable for any injury caused to other works in the correction of piping. The Contractor shall closely coordinate with other works during the entire stage of execution.

A minimum distance between different services shall be maintained as shown on the Drawings and/or as approved by the Engineer.

Pipes should be installed in such a manner that minimum distance should always be maintained between pipe and wall, beams, columns, etc. Pipes shall be supported on hangers and brackets as shown on the drawings or as directed by the Engineer.

Waste-water outlet from each fixture shall be individually trapped. Each vent terminal shall extend to the outer air and be so installed as to minimize the possibilities of clogging and the return of foul air to the building.

When the roughing-in is completed, the plumbing system shall be subjected to test prior to concealing the roughing-in, in order to ascertain that all threads and connections are watertight.

Cast iron soil and drainage fittings for change in direction shall be used as follows:-

*Vertical to horizontal : short sweep or long-turn for diameter 75 mm and larger; long sweep or extra-long-turn for less than 75 mm. dia.

*Horizontal to vertical : quarter bend or short turn.

All fittings with hubs shall be aligned so that the hub faces upstream. No drainage or vent piping shall be drilled.

All exterior openings provided for the passage of piping shall be properly sealed with snugly fitting collars of metal or other approved rodent-proof material securely fastened into place.

Joints at the roof, around vent pipes, shall be made water-tight by the use of lead, copper, galvanized iron, or other approved flashing or flashing material. Exterior wall openings shall be made watertight.

Each length of pipe & each pipe fitting, trap, fixture, & device used in a plumbing system shall have cast, stamped or indelibly marked on it the maker's mark or name, the weight, type & classes of the product, when such marking is required by the approved standard that applies.

Where different sizes of pipes, or pipes and fittings are to be connected, the proper size increasers or reducers or reduced fittings shall be used between the two sizes.

Any fitting or connection which has an enlargement, chamber, or recess with a ledge, shoulder, or reduction of pipe area that offers an obstruction to flow through the drain pipe is prohibited. The vertical distance from the fixture outlet to the trap weir shall not exceed 600 mm. Each fixture trap shall have a water seal of not less than 50 mm and not more than 100 mm.

Full S, bell, crown vented traps and traps/depending for their seal upon the action of movable parts are prohibited. No fixture shall be double trapped. Where fixture comes in contact with wall and floors, the joint shall be water-tight. Piping in ground shall be laid on a firm bed for its entire length.

Piping in the plumbing system shall be installed without undue strains and stresses. Vertical piping shall be securely held to keep the pipe in alignment and carry the weight of the pipe and contents. Horizontal piping shall be supported to keep it in alignment and prevent sagging. Hangers and anchors shall be of metal of sufficient strength to maintain their proportional share of pipe alignments and prevent rattling. Hangers and anchors shall be securely attached to the building under construction. It must be clearly understood that the Contractor shall be

fully responsible for hangers and supports and shall obtain prior approval of design as to the shape, material, dimensions, spacing etc.

Piping in concrete or masonry walls or footings shall be placed or installed in sleeves which will permit access to the piping for repair or replacement.

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

The run and arrangement of all pipes shall be as shown on the Drawings and as directed during installation. All vertical pipes shall be erected plumb and shall be parallel to wall and other pipes. All horizontal runs of piping shall be kept close to walls. If required to change the location etc. during the currency of the work, the Contractor will do so at no additional cost. Screwed joints in G.I. pipes shall be made perfectly tight, without the use of any filler except approved jointing compound or tape. Wherever required to make flanged joints, they shall conform to BS 10 Table D.

Furnish and install all pipe passing through floors and walls with sleeves of G.I. sheet, 18 gauge, the inside dia. of which shall be at least 1/2" greater than the outside dia of the pipe passing through it. Sleeves in exterior walls and pits shall have anchor flanges and space between pipe and sleeve shall be caulked and sealed watertight. At waterproof locations, an approved water-proof type pipe sleeve shall be provided.

All embedded water supply piping shall be wrapped with approved anti-corrosion polyethylene tape. All exposed piping shall be painted with two coats of enamel paint over a coat of red oxide.

Pipes laid in trenches (external) shall be protected by applying coating of primer grade 10/20 bitumin+hyacinth cloth mopped with bitumen (50% grade 80/100 & 50% grade 10/20).

Insulation

All hot water supply and return piping shall be insulated as specified herein. Prior to insulation the pipes shall be hydraulically tested and cleaned.

Nominal Pipe Dia. (mm)	Thickness of per-form Fiber glass pipe insulation. (mm)
15 (1/2")	25
20 (3/4")	25
25 (1")	25
32 (1-1/4")	25
40 (1-1/2")	25
50 (2")	25
65 (2-1/2")	25
75 (3")	25

Insulation shall consist of pre-formed fiberglass pipe insulation, with factory applied reinforced aluminum vapor barrier, single layer in semi-circular halves, consisting of long, fine glass fibers, bonded with a temperature resistant binder, free from shot or coarse fibers, damage resistant, light in weight, easy to handle, cut and fit. The product shall comply with the requirements of B.S. 3958: Part 4. The insulation shall be rotproof, odorless, non-hygroscopic, and shall not sustain vermin. The fiberglass insulation shall be covered with a layer of approved polyethylene tape in the field. Further reinforcement shall be provided by the use of 20 mm wide soft aluminum bands, generally spaced at 457

mm and on either side of elbows and tees. All butt joints shall be sealed with self-adhesive type of approved quality adhesive tape.

All trimmed sections shall be secured by wrapping of approved type of self adhesive tape to form a complete waterproof seal. All work shall be done in a neat and workmanlike manner, and should reflect recommended practice.

All Hot water and Hot water return lines concealed in walls only, shall be provided with Glass wool blanket insulation.

Pipe work Supports

All supports, clips, steel rods and hangers shall be of mild steel painted with two coats of approved metallic zinc primer. All clips and brackets shall be equipped with 9 mm sectional rubber liners (shore-hardness A 40+5°).

Pipe work supports shall be installed in order to allow free movement due to expansions and contraction. Supports shall be arranged adjacent to joints, changes of direction and branches. Each support shall carry the overall weight of pipework and water to be borne by it. The intervals between pipe supports shall not exceed the following :

Maximum interval between supports (metres)

Nominal Dia mm	Steel pipes	
	Horizontal	Vertical
10	1.7	1.7
15	2.0	2.0
20	2.4	2.4
25	2.7	2.7
32	2.7	2.7
40	3.0	3.5
50	3.4	3.9
65	3.7	4.3
80	3.7	4.3
100	4.1	4.6

Dimensions of Support Materials

Nominal Dia mm	Flat iron bands mm	Support rods mm	U-bolts mm
10	25 x 3	6	6
15	25 x 3	6	6
20	25 x 3	6	6
25	25 x 3	6	6
32	40 x 5	10	10
40	40 x 5	10	10
50	40 x 5	10	10
65	50 x 6	12	12
80	50 x 6	12	12
100	50 x 6	12	12

Single pipes hung from floor slabs shall be supported on rod hangers. Where two or more pipes are involved a channel or angle from shall be fitted to the underside of slab by two hangers and the pipes shall be supported from the channel iron by rod hangers and flat iron hands.

All hanger rods shall have double nuts and beveled washers to allow the hanger rod to swing.

Multiple pipe runs along walls shall be supported on purpose made substantial angle and channel frames securely fixed to the wall, floor and ceiling as necessary. All pipes shall be arranged to slide on the steel supports and U-bolts shall be provided to form a rigid guide.

Exposed pipe work shall be supported on channel, angle iron or with U-bolts to form a rigid guide.

All U-bolts, except used as anchors, shall have a pair of nut and washers on each leg with the supporting steel flange clamped tight between the pair of nuts to form a rigid guide and allowing the pipe to slide axially,. U- bolts shall be provided on alternate pipe bracket.

Small pipe work running along skirting shall be supported by standard built-in or screw-on type clips.

Pipes shall be individually supported. Pipes shall not hung from other pipes.

Points at which pipes pass through walls, floors, connections to plant, equipment and heat emitters, etc. do not constitute points of supports for the pipes.

Vertical pipes shall be supported at the base or at anchor points to withstand the total weight of the riser. Brackets from risers shall not be used as a means-of support for the riser.

Vibration isolators to be provided with the hangers as approved by the Engineer.

5.3 POLYPROPYLENE RANDOM PIPES & Jointing

5.3.1 Jointing Techniques

The surfaces of the pipes and fittings must be clean and without impurities. Pipe ends must be clean, cut at right angles. It is recommended to cut 1cm from the pipe ends in order to prevent possible micro-cracking due to incautious handling. Before carrying out the welding, check that the poly-fusion device operates correctly and that it reaches the required welding temperature ($260^{\circ}\text{C} \pm 5$).

Jointing is done by heat fusion (welding) by means of welding machine. Welding is carried out by means of heating simultaneously the male and female parts to be joined together, once the welding temperature is reached the joint is made and held for cooling time. (see table I below)

5.3.2 Welding Instructions using socket welding machine

- i. Check whether the welding tool corresponds to the size you need to join.

- ii. The welding tool/device has reached the necessary operating temperature of 260°C \pm 10
- iii. Cut the pipe at right angles to the pipe axis by using cutter or a hack saw.
- iv. Clean the pipe from burrs, cutting and chips
- v. Mark the welding depths at the end or pipe
- vi. Push the end of pipe up to the marked welding depths in the welding tool, at the same time push the fitting, into the welding tool.
- vii. After the stipulated heating time quickly remove pipe and fitting from the welding tools and join them immediately, forcing the pipe into the fitting until the marked welding depth is covered by the bead of Polypropylene from the fitting
- viii. The joint elements have to be fixed and aligned within the specified assembly time.
- ix. After the cooling time the fused joint is ready for use. The heating time starts when pipe and fitting have been pushed to the correct welding depth in the welding tool

Est. Diameter (mm)	Welding Depth (mm)	Heating Time DVS 2207* (sc).		Heating time (sc.)	Cooling Time (min.)
20	14.0	5	8	4	2
25	15.0	7	11	4	2
32	16.5	8	12	6	4
40	18.0	12	18	6	4
50	20.0	18	27	6	4
63	24.0	24	36	8	6

The heating time have to be increased 50% if average temperature is under + 5°C

5.3.3 Welding of PPR Pipes

- i. Cutting of pipe at right angle with a cutter.
- ii. Marking of welding depth on the pipe end.
- iii. Simultaneous heating of both pipe and fittings according to required heating time (as per given data).
- iv. Pushing of pipe end into the fitting and alignment of the assembly within specified time period
- v. Finish joint.

5.3.4 Installation Principles

5.3.4.1 Fastening technique for open installation

The selection of fastening material and its application have to be determined as:-

1. Fixed Point
2. Sliding Point

Pipe clamps are such as to meet all requirements and ensure that no mechanical damage on the pipe surface can occur.

5.3.4.2 Fixed Point

Valves and connections resisting to bending stresses have to be fastened by means of points. In particular cases the fixed points are to be positioned closed to branches or wall passages. The axial expansion will be compensated between two points. To assess the resistance of the fixed points one has to take into account the stresses to which they will be subjected, caused by linear expansion, weight of the piping and weight of the transportation fluid. Fixed points should be delimited on both sides of the clamp, avoiding oneself of the rim fittings or valves.

5.3.4.3 Sliding Point

The sliding points must keep the system aligned and support it, and allow the axial sliding of the piping as well. The sliding are to be firmly mounted in order to prevent vibration and transmission of noise.

Distance between the support points in cm.

<i>Pipe diameter</i>	<i>Temperature in °C</i>		
	20	50	80
20mm	85	70	60
25mm	85	80	70
32mm	100	85	85
40mm	110	100	90
50mm	125	110	90
65mm	140	125	105

5.4 WATER PIPES AND FITTINGS OUTSIDE BUILDING (EXTERNAL WORKS)

5.4.1 HANDLING

Pipe and accessories shall be handled in such a manner as to ensure their delivery to the trench in sound, un-damaged condition. If any pipe or fitting is damaged, the repair or replacement shall be made by the Contractor at his expenses in a satisfactory manner. No other pipe or material of any kind shall be placed inside of a pipe or fittings. Pipe shall be carried into position and not dragged. The interior of pipe and accessories shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved method. Before installation, the pipe shall be inspected for defects. Material found to be defective before or after laying shall be replaced with sound material without additional expense to the Employer. Rubber gaskets that are not to be installed immediately shall be stored in a cool dark place and protected against the direct rays of the sun.

5.4.2 CUTTING OF PIPE

This shall be done in a neat and workman-like manner without damage to the pipe. Unless otherwise authorized by the Engineer or recommended by the manufacturer, cutting shall be done with a

mechanical cutter of approved type. Wheel cutters shall be used wherever practicable.

5.4.3 LOCATION

Where the location of the water pipe is not clearly defined by dimensions on the Drawings, the water pipe shall be located as directed by the Engineer.

5.4.4 DEFLECTION

Maximum allowable deflections from a straight line or grade, as required by vertical curves, horizontal curves, or offsets will be 2^o degrees unless otherwise recommended by the manufacturer. If the alignment requires deflections in excess of the specified limitations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set forth, as approved.

5.4.5 PLACING AND LAYING

Pipe and accessories shall be carefully lowered into the trench by means of derrick ropes, belt slings, or other suitable equipment. Under no circumstances shall any of the water line materials be dropped or dumped into the trench. Care shall be taken to avoid abrasion of the pipe coating. Poles used as levers shall be of wood and shall have broad flat faces to prevent damage to the pipe. Except where necessary in making connections with other lines or authorized by the Engineer pipe shall be laid with the bells facing in the direction of laying. The full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate bell coupling and joints. Pipe that has the grade or the joint disturbed after laying shall be taken out and re-laid. Pipe shall not be laid in water shall be kept out of the trench until the materials in the joints have hardened or until caulking or jointing is completed. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no trench water, earth, or other substances will enter the pipes or fittings. Where any part of a coating or lining is damaged, the repair shall be made by the Contractor at his expense in a satisfactory manner. Pipes shall be installed in accordance with recommendations of the pipe manufacturer. Pipe ends left for future connections shall be valved, plugged or capped, and anchored, as shown or as directed, where connections shall be made by using specials and fittings to suit the actual conditions.

5.4.6 JOINTING

The joints shall be in accordance with the recommendations of the manufacturer or as approved by the Engineer.

Connections between different types of pipes and accessories shall be made with transition fittings where recommended by the pipe manufacturer.

Service connections shall be made as indicated and in accordance with the recommendations of the pipe manufacturer.

5.4.7 THRUST BLOCKS

Plugs, caps, tees, bends and fire hydrants shall be provided with concrete thrust blocks. Backing shall be placed between solid ground and the hydrant or fitting to be anchored. The area of bearing shall be as

shown on the Drawing. The backing shall be so placed that fitting joints shall be accessible for repair. The concrete shall be class C plain cement concrete.

5.4.8 PIPE BEDDING

Fine sand as pipe bedding material shall be used for bedding of pipes and fittings. The sand shall be free from clay, silt, salts, organic impurities and debris. Approval of pipe bedding materials shall be obtained by the site Engineer prior to placing.

5.4.9 FLUSHING

The Contractor shall provide facilities for flushing the line. Water for flushing the line shall be arranged by the Contractor. Flushing of line shall be done section by section. For each valved section of pipeline the Contractor shall make a temporary hose connection between the water pipeline and the pipeline under test. Water shall be pumped into the section flushed. Other arrangements for storing and pumping of water shall be subject to the approval of Engineer. Due precautions shall be taken by the Contractor for the disposal of water. The pipeline shall be flushed by keeping all the branching pipes open. Flushing shall be continued until clean water starts flowing through the other end. Section by section, the entire pipeline shall be flushed at a minimum flushing velocity of 2.5 ft./sec.

5.4.10 PIPELINE DISINFECTION

The Contractor shall furnish all equipment, labour and material for the proper disinfection of the pipeline. Disinfection shall be accomplished by chlorination after the lines have been tested for leakage but before they have been connected to the main system. Disinfections of the pipelines shall be done in the presence of the Engineer's representative with equipment approved by him.

- **Chlorination** A chlorine and water mixture shall be supplied by means of a solution feed chlorination device. The chlorine solution shall be applied at one end of the pipeline through a trap, in such a manner that as the pipeline is filled with water, the dosage applied to the water entering the pipe shall be at least (25 p.p.m) or enough to meet the requirements given hereinafter.
- **Retention Period** Chlorination water shall be retained in the pipeline for a period of at least 24 hours. After the chlorine treated water has been retained for the required time, the chlorine residual at the pipe extremities and at such other representative points shall be at least 10 parts per million. This procedure shall be repeated until the required residual chlorine concentration is obtained.
- **Chlorination of Valves** During the process of chlorination the pipeline, all valves or other appurtenances shall be operated while the pipeline is filled with the heavily chlorinated water.

5.4.11 FINAL FLUSHING

Following complete disinfection of the pipeline, all treated water shall be thoroughly flushed from the pipeline at its extremities. Treated water and water used for flushing the pipelines shall be disposed of in a manner instructed by the Engineer. Fresh treated water shall be filled in the line and water tested from presence of coliform. the test result should

indicate negative coliform presence. If the test indicates any positive coliform, the entire process of disinfection shall be repeated or improved upon until coliform free samples are obtained.

5.4.12 SAMPLING AND TESTING

Disinfection of the pipeline and appurtenances shall be the responsibility of the Contractor. The first set of samples will be collected for analysis by the Engineer. Should the samples reveal presence of coliform the Contractor shall again disinfect the pipeline and appurtenances at no extra cost to the Employer for sampling and testing for subsequent retests until coliform free samples are obtained. The charges for re-sampling and retesting shall be recovered from the Contractor.

5.4.13 CLEAN-UP

Upon completion of the installation of the water supply lines, distribution system and appurtenances, all debris and surplus materials resulting from the work will be removed and disposed off in a manner satisfactory to the Engineer

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

All cast iron soil pipes and fittings shall be installed to the lines and grades shown on the drawings or as directed by the Engineer. When required to be installed above ground floor level, suitable and substantial number of hangers and supports of approved type and make shall be provided. No piping shall be hung from the piping of other systems. Clamps shall be provided on not more than 1.5 meter centres or a minimum of one hanger per each length of pipe whichever is smaller. Where excessive numbers of fittings are installed, additional clamps will be provided.

All steel clamps, hangers and support etc. shall be given one coat of red oxide primer and two coats of synthetic enamel paint. All exposed C.I. soil/vent pipes shall be given two coats of synthetic enamel paint. Materials for painting shall be high quality product of well-known manufacturer and will be approved by the Engineer before using. The instructions of the manufacturer regarding all painting work shall strictly be adhered to. Pipes passing through walls, floors, etc. shall be provided with sleeves of approved design. All vent pipes to be installed in the system shall be provided with approved cowl and will rise at least 0.70 meter above the roof.

Caulked joints for cast iron bell-and-spigot soil pipe shall be firmly packed with oakum or kemp and filled with molten lead not less than 22 mm deep and not to extend more than 3 mm below the rim of the hub. Rubber ring joints shall also be allowed. No paint, varnish, or other coatings shall be permitted on the jointing material unit after the joint has been tested and approved

Pipes passing through walls, floors, etc. shall be provided with sleeves of approved design. All vent pipe to be installed in the system shall be provided with approved cowl and will rise at least 0.70 meter above the roof.

Special requirements for uPVC pipes and fittings are as under:

Maximum Interval between Supports (m)
(Support centers for uPVC pipe work systems)*

Nominal Diameter, d _e (mm)	PIPEWORKS	
	Horizontal (10xd _e) (m)	Vertical (m)
40	0.40	1.2
50	0.50	1.5
75	0.75	2.0
110	1.10	2.0

* The values shown are for general installations only. Attention is drawn to special requirements that may be needed in more demanding applications.

All steel clamps, hangers, supports etc. shall be given one coat of red oxide primer and two coats of synthetic enamel paint.

All exposed uPVC pipes shall be given two coats of approved colour water based emulsion paint (note that oil based paints must be avoided).

PRECAUTIONS

Following points describe how an uPVC must be cared of:

- a. The depth of concrete cover above uPVC pipe depends on the pipe gradient. However, a minimum of 1 (one) inch concrete cover must be provided.
- b. When using cemented joints, the adhesive should be given sufficient opportunity to harden before the pipe is concreted in.
- c. Horizontal lines that are concreted-in should be anchored against upward movement and should be adequately secured while the concrete is being poured.
- d. During the pouring and setting of concrete, necessary care shall be taken to prevent physical damage to the pipes.
- e. When using heated concrete or when steaming the concrete, the sensitivity of uPVC material to temperature changes should be borne in mind.
- f. Concrete mortar that is used before concreting-in shall include no sharp-edged material.
- g. Avoid excessive misalignment of the pipes.
- h. Avoid excessive tightness of joints.
- i. Provide sufficient expansion joints to allow thermal movement or regression.
- j. Use only allowed cleaning & descaling techniques for different situations & locations (as described in ISO/TR 7024-1985E) when a pipeline gets choked or blocked.

DELIVERY CONDITIONS

The internal and external surfaces of pipes and fittings shall be smooth and free from grooving, blistering and any other surface defect. The materials shall not contain visible impurities or pores. Pipe ends shall be cleanly cut, and the ends of pipes and fittings shall be square with the axis of the pipe

MARKINGS

Pipes, fittings and sealing rings shall be marked clearly and indelibly so that legibility is maintained for the life of products under normal conditions of storage, weather and use.

The markings may be integral with the product or on a label. The markings shall not damage the product.

PIPES

Pipes shall be marked with at least the following information:

- a. Manufacturer's name or trade mark;
- b. Pipe material;
- c. Nominal diameter of pipe;
- d. Nominal wall thickness of pipe
- e. Manufacturing information, in plain text or in code, providing tractability of the production period to within the year and month and the production site if the manufacturer is producing at several national or international sites.
- f. The number of this International Standard.

Pipes with a nominal laying length up to and including z_2 meters shall be marked with at least once. Pipes with a nominal laying length greater than z_2 meters shall be marked at intervals of z_3 meters at the most. The values of z_2 and z_3 shall be as specified by the authorities in each country.

Fittings

Fittings shall be marked with at least the following information:

- a. Manufacturer's name or trade mark;
- b. Fitting material (may be given on packing only in the case of PVC, provided this information is not required on each article by national authorities);
- c. Nominal diameter of fitting;
- d. Classification (where applicable)
- e. Values of angles, if any;
- f. Manufacturing information, in plain text or in code, providing tractability of the production period to within the year and month and the production site if the manufacturer is producing at several national or international sites (may be given on packing only, provided this information is not required on each article by national authorities);
- g. The number of this International Standard (may be given on packing only, provided this information is not required on each article by national authorities).

Sealing Rings

Sealing rings shall be marked with at least the following information:

- a. Manufacturer's name or trade mark;
- b. Nominal diameter of ring;
- c. Manufacturing information, in plain text or in code, providing traceability of the production period to within the year and month and the production site if the

manufacturer is producing at several national or international sites.

6. TESTING AND COMMISSIONING

6.1 G.I. & PPR COLD AND HOT WATER PIPES

All water distribution system shall be tested whole or in part to 2 times the working pressure with a minimum test pressure of 100psi. The contractor shall pay for all device, materials, supplies, labor and power required for the test. The test will be run for two hours at the specified pressure and there should be no leakage in the system. Defects revealed by the test shall be repaired and the whole test rerun until the system proves to be satisfactory.

After all the pipes and fixtures have been properly laid and tested, they shall be flushed clean with water and then disinfected with water solution of chlorine of at least 50 ppm strength for a contact period of 6 hours. The system will be finally flushed with clean water.

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

The entire system of drains, waste, and vent piping inside the building shall be tested by this Contractor under a water test. Every portion of the system shall be tested to a hydrostatic pressure equivalent to at least 3-meter head of water. After filling this Contractor shall shut off water supply and shall allow it to stand two hours, under test during which time there shall be no loss or leakage.

The Contractor shall furnish and pay for all devices, materials, supplies, labor and power required in connection with all tests. All tests shall be made in the presence of and to the satisfaction of the Engineer.

The Contractor shall also be responsible for the repair of this work & other trades work that may be damaged or disturbed by the tests. Defects disclosed by the tests repaired. Work shall be replaced with new work without extra cost to the Employer. Tests shall be repeated as directed, until all work is proven satisfactory.

All fixtures shall be tested for soundness, stability, support and satisfactory operation.

7. MEASUREMENT AND PAYMENT

7.1 COLD & HOT WATER PIPE

7.1.1 Measurement

Measurement for acceptably completed works of supply and installation of cold and hot water pipes shall be in running meter length.

- a. In building works, no measurement shall be made for earthworks, pipe fittings, jointing, hangers, clamps, brackets, sleeves, insulation, cutting and breaking concrete and then making it good, applying protective painting, coating, cleaning, testing and disinfecting etc. and the measurement will be for the full work specified herein.
- b. In external works, no measurement shall be made for pipe fittings, jointing, insulation, cutting and breaking concrete and then making it good, applying protective painting, coating, cleaning, flushing, testing and disinfecting etc. and the measurement will be for the full work specified herein. However, earthworks (excavation, backfilling, sand bedding), and thrust blocks shall be paid separately as specified in Bill of Quantities.

7.1.2 Payment

Payment for acceptable measured quantity will be made at the unit rate per running Foot length of cold and hot water pipes quoted in the Bill of Quantities. The amount bid shall be the full payment for completion of the work in all respects as specified herein.

7.2 uPVC and C.I. SOIL, WASTE & VENT PIPES

7.2.1 Measurement

Measurement for acceptably completed works of supply and installation of uPVC & C.I. pipes, will be in running Feet length and the work to be done shall include all pipe fittings, jointing, hangers, clamps, brackets, sleeves, cutting and breaking concrete and then making it good, applying protective painting, coating, cleaning and testing.

7.2.2 Payment

Payment will be made at the unit rate of bid per running Feet length of pipe acceptably supplied and installed. The amount bid shall be full payment for the work specified herein.

7.3 PLUMBING FIXTURES

7.3.1 Measurement

Measurement for plumbing fixtures will be made as per actual number acceptably installed. The Contractor's bid against these items shall include installation of complete unit as specified herein, inclusive of all work from inlet connection of water supply to outlet connection with the sanitary system, complete as per Contract Documents and/or as directed by the Engineer.

7.3.2 Payment

Payment for plumbing fixtures shall be made at the applicable unit price per number bid for the respective item in the Bill of Quantities. The amount bid shall be full payment for the work specified herein.

7.4 MISCELLANEOUS ITEMS

7.4.1 Measurement

Measurement for acceptably completed works of floor drains, roof drains, cleanouts, glass mirror, towel rail, toilet paper holder, soap trays, mirror trays, water coolers, water heaters, etc. shall be made on the basis of actual number acceptably installed in position. The Contractor's bid against these items shall include installation complete as specified herein and/or as shown on the Drawings.

7.4.2 Payment

Payment for acceptably measured quantity of floor drains, roof drains, cleanouts, glass mirrors, towel rails, toilet paper holders, soap trays, mirror trays electric water coolers, water heaters, etc. shall be made at the applicable unit rate per number quoted in the Bill of Quantities. The bid amount shall be full payment for the works specified herein and as shown on the Drawings.

*** End of Section 5100 ***