UNITED NATIONS HIGH COMMISSIONER FOR REFUGEES (UNHCR)

CONSTRUCTION OF VOCATIONAL TRAINING INSTITUTE FOR WOMEN BUFFER ZONE, KARACHI

TECHNICAL SPECIFICATIONS

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CIVIL WORKS

SECTION - 2100

FORMWORK

SECTION - 2100

FORMWORK

1.0 **SCOPE**

The work under this section of the Specifications consists of furnishing all plant, labour, equipment, appliances and materials and in performing all operations in connection with the supply and installation of formwork for the purpose of containing concrete during placement and consolidation in the required shape and form.

2.0 **GENERAL**

It shall be the responsibility of the Contractor to perform the work by engaging well trained and experienced staff.

3.0 **MATERIALS**

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

3.1 **Timber**

Form framing, sheathing and shoring.

3.2 **Plywood**

Form sheathing and panels.

3.3 **Steel**

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

3.4 **Form Ties Anchors and Hangers**

For securing formwork against placing loads and pressures.

3.5 **Coatings**

Facilitate form removal.

3.6 **Steel Joints**

For formwork support.

3.7 **Steel frame shoring**

For formwork support.

4.0 **DELIVERY AND STORAGE**

4.1 **Delivery**

The delivery of formwork components shall be made in a manner so as not to cause damage.

4.2 **Storage**

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

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

5.0 **WORKMANSHIP**

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

Where required details and locations of special forms to be used are set out on the drawings. The Engineer shall reject any formwork in any part of the work which has been constructed with a non- approved formwork. Approval of form work by the Engineer shall be one of these conditions to be fulfilled before concreting. The Engineer shall reject any concreting which may not conform to the approved model.

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

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

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

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

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

5.5 Requirements for `facing materials' are given in the Section relevant to `Finishing of Formed Surfaces.'

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

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

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

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

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

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

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

5.13 Form ties shall be constructed so that the ends or end fasteners can be removed without causing appreciable spalling at the faces of the concrete. After the ends or end fasteners of form ties have been removed, the embedded portion of the ties shall terminate not less than twice the diameter or twice the minimum dimension of the tie from the formed faces of concrete to be permanently exposed to view and in no case shall this distance be less than 19mm (3/4 in.) when the formed face of the concrete is not to be permanently exposed to view from ties may be cut off flush with the formed surfaces.

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

5.14 At construction joints contact surface of the form sheathing for flush surfaces exposed to view shall overlap the hardened concrete in the previous placement by no less than 25mm (1 in.). The forms shall be held against the hardened concrete to prevent offsets or loss of mortar at the construction joint so as to maintain a true surface.

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

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

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

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

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

5.20 Forms shall be sufficiently tight to prevent leakage of grout or cement paste. Board forms having joints opened by shrinkage of the wood shall be removed and replaced. Plywood and other wood surfaces not subject to shrinkage shall be sealed against

absorption of moisture from the concrete by either (1) a field applied, approved form oil or sealer, or (2) a factory applied non-absorptive liner. When forms are coated to prevent bond with concrete, it shall be done prior to placing of the reinforcing steel. Excess coating material shall not be allowed to stand in puddles in the forms nor allowed to come in contact with the concrete against which fresh concrete will be placed. Care shall be taken that such approved composition is kept out of contact with the reinforcement. Where as-cast finishes are required, materials, which will impart a stain to the concrete, shall not be applied to the form surfaces. Where the finished surface is required to be painted, the material applied to form surfaces shall be compatible with the type of paint to be used.

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

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

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

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

- Side of slab (shores of 6 days props left under)

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

- Removal of shores or props to slabs:

    1. Spanning upto 4 metre (13 ft.) 10 days.
    2. Spanning over 4 metre (13 ft.) 16 days.

- Removal of shores or props to beams:

    1. Spanning upto 6 metre (20 ft.) 18 days.
    2. Spanning over 6 metre (20 ft.) 25 days.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

5.31 Formwork for concrete pavement shall be made of steel of an approved section, with a base width of at least 200 millimeters (8 in.) and the depth shall be equal to the thickness of the pavement at the edge as shown on the plans. The forms shall be staked with steel stakes, and stakes shall be of a length approved by the Engineer. Each section of forms shall have a stake pocket at each end and at intervals of not more than 1.5 meters (5 ft.) between ends. The stake pockets shall have approved devices for locking the form to the steel stakes. Each section of forms shall be straight and free from bends and warps at all times. No section shall show a variation greater than 3millimeter in 3 meters (1/8 inch in

10 ft.) from a true plane surface on the top of the form, and the inside face shall not vary more than 6 millimeters (1/4 in.) from a plane surface.

Before placing forms, the underlying base shall be to the required grade, and shall be firm and compact. The forms shall have full bearing upon the foundation throughout their length and shall be placed with exactness to the required grade and alignment of the edge of the finished pavement. They shall be so supported during the entire operation of placing, tamping and finishing the pavement that they will not deviate vertically at any time more than 3 millimeters (1/8 in.) from the proper elevation.

Forms shall not be removed for at least twelve (12) hours after the concrete has been placed. Forms shall be carefully removed in a manner to avoid damage to the pavement. Under no circumstances will the use of pry bars between the forms and the pavement be permitted. Pavement, which in the opinion of the Engineer, is damaged due to the careless removal of forms shall be repaired by the Contractor, as directed by the Engineer, at the Contractor's own expense. Forms shall be thoroughly cleaned and oiled each time they are used.

When pavement is placed adjoining existing concrete pavement upon which the finishing machine will travel, any irregularities in the old pavement shall be ground down to a true, uniform surface, of sufficient width to accommodate the wheels of the finishing equipment, if necessary to obtain proper smoothness of the pavement.

6.0 MEASUREMENT AND PAYMENT

Except otherwise specified in the Bill of Quantities no payment will be made for the works involved within the scope of this section of the specifications.

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

*** End of Section 2100 ***

SECTION – 2300

PLAIN AND REINFORCED CONCRETE

SECTION 2300

PLAIN AND REINFORCED CONCRETE

1. SCOPE

The work under this section of the specification consists of furnishing all plant, labour, equipment, appliances and materials and in performing all operations in connection with the supply and installation of plain and reinforced concrete work complete in any floor and at any height as per drawings except where specifically stated in the relevant item of Bill of Quantities, in strict accordance with this section of the specifications and the applicable drawings, and subject to the terms and conditions of the Contract. The scope of this section of specification is covered with detailed specifications as laid down herein.

2. GENERAL

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

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

2.3 For special concrete finish and for special methods of construction (e.g. slip forms), formwork shop drawings shall be designed and prepared by the Contractor, at his own cost. Approval of shop drawings as well as that of actual samples of concrete finish shall be obtained before work is commenced.

3. APPLICABLE STANDARDS

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

3.1 Pakistan Standards

PS 177	Compaction factor test.
PS 232	Portland Cement (ordinary & rapid hardening).
PS 243	Natural aggregates for concrete.
PS 279	Abrasion of coarse aggregates by the use of Los Angeles machine.
PS 280	Determination of aggregates crushing value.
PS 281	Organic impurities in sand for concrete aggregates.
PS 282	Material finer than No. 200 B.S. test sieve in aggregates, method of test for.
PS 283	Soundness test for aggregates by the use of sodium sulphate or magnesium sulphate.
PS 284	Sampling aggregates for concrete.
PS 285	Sieve or screen analysis of fine and coarse aggregates.
PS 286	Description and classification of mineral aggregates.
PS 421	Sampling fresh concrete.
PS 422	Slump test for concrete.
PS 560	Making and curing concrete compression test specimen in the field.
PS 612	Sulphate-resistant Portland cement type `A' and sampling fresh concrete in the laboratory.
PS 716	Mixing and sampling fresh concrete in the laboratory.
PS 717	Compacting factor test for concrete.
PS 746	Definitions and terminology of cements.
PS 849	Making and curing concrete compression test cubes.

3.2 ASTM (American Society for Testing and Materials)

B 370	Copper sheet and strip for building construction.
C 33	Concrete Aggregates.

C	40	Organic impurities in sand for concrete.
C	87	Effect of organic impurities in fine aggregates on of mortar.
C	88	Soundness of aggregates.
C	94	Ready mixed Concrete.
C	109	Compressive strength of hydraulic cement mortars.
C	117	Material finer than No.200 (0.075mm) sieve.
C	123	Light-weight pieces in aggregates.
C	125	Concrete and concrete aggregates.
C	127	Specific gravity and absorption of coarse aggregate.
C	128	Specific gravity and absorption of fine aggregate.
C	131	Resistance to abrasion of small size coarse aggregates.
C	136	Sieve or screen analysis of fine and coarse aggregate.
C	142	Clay lumps and friable particles in aggregates.
C	143	Slump of Portland Cement Concrete.
C	144	Aggregate for masonry mortar.
C	150	Portland Cement.
C	156	Water retention by concrete curing material
C	171	Sheet material for curing concrete.
C	185	Air content or hydraulic cement mortar.
C	188	Density of hydraulic cement.
C	191	Time of setting of hydraulic cement by vicat needle.
C	260	Air entraining admixtures for concrete.
C	289	Potential reactivity of aggregate.
C	309	Liquid membrane-forming compounds for curing concrete.
C	330	Lightweight aggregates for structural concrete.
C	331	Lightweight aggregates for concrete masonry.
C	332	Lightweight aggregates for insulating concrete.
C	494	Chemical admixtures for concrete.
C	535	Resistance to abrasion of large size coarse aggregates.
C	567	Unit weight of structural lightweight concrete.
D	75	Aggregate sampling.
D	994	Preformed expansion joint filler for concrete.
D	1190	Concrete joint sealer (hot poured elastic type).
D	1751	Preformed expansion joint filler for concrete paving and structural construction.
D	1752	Preformed sponge rubber and cork expansion joint fillers for concrete paving and structural construction.
D	1850	Concrete joint sealer (cold application type).
E	11	Wire cloth sleeves for testing purposes.
E	96	Water vapour transmission of materials in sheet form.
E	154	Materials for use as vapour barrier under concrete slabs.
E	337	Relative humidity by wet and dry bulk psychrometer.

3.3 ACI (American Concrete Institute)

211.1	Recommended practice for selecting proportions for normal and heavy weight concrete.
214	Recommended practice for evaluation of strength test result of concrete
301	Specifications for structural concrete for buildings.
304	Recommended practice for measuring, mixing, transporting and placing concrete.
305	Hot weather concreting.
308	Recommended practice for curing concrete.
309	Recommended practice for consolidation of concrete.
318	Building code requirements for reinforced concrete.
347	Recommended practice for concrete formwork.
512	Precast structural concrete in building.
517	Low pressure steam curing.
533	Fabrication, handling and erection of Precast concrete wall panels.

3.4 British Standards

BS	12	Portland cement, ordinary and rapid hardening.
BS	410	Test Sieves.
BS	812	Methods for the sampling and testing of mineral aggregates, sands and fillers.
BS	882	Coarse and fine aggregates from natural sources.
BS	1305	Batch Mixer.
BS	1881	Methods of testing and sampling concrete.
BS	3148	Tests for water for making concrete.
BS	3837	Expanded polystyrene boards.
BS	5328	Structural Concrete.,
BS	3869	Rigid expanded polyvinyl chloride for thermal insulation.
BS	3927	Phenolic foam materials for thermal insulation and building applications.
BS	4027	Sulphate-resisting Portland cement.
BS	8110	Structural use of concrete.
CP	114	Structural use of reinforced concrete in buildings.
CP	116	Structural use of Precast concrete.
CP	5337	The structural use of concrete for retaining aqueous liquids.

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

4. MATERIALS

4.1 Aggregates

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

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

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

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

Total Passing B.S. Sieve			Percent by weight
3 in.	(76.20 mm)	:	100
1.5 in.	(38.10 mm)	:	95-100
0.75 in.	(19.05 mm)	:	30-70
0.38 in.	(9.52 mm)	:	10-35
0.19 in.	(4.76 mm)	:	0-5

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

Total Passing B.S. Sieve			Percent by weight
.5 in.	(38.10 mm)	:	100
0.75 in.	(19.05 mm)	:	95-100
0.38 in.	(9.52 mm)	:	25-55
0.19 in	(4.76 mm)	:	0-10

4.1.5 Wherever feasible, the nominal maximum size of aggregate for cast- in- place reinforced concrete slabs and other members, shall be 3/4 inch. If there are difficulties in placing such a concrete the maximum size may be restricted to 1/2 inch provided the requirements for strength are satisfied. The grading requirements of 1/2 inch or 3/8 inch down aggregate shall be agreed to with the Engineer as per relevant ASTM/BS standards.

4.1.6 The nominal maximum size of the aggregate for Precast concrete shall not be larger than one fifth of the narrowest dimension between sides of forms, or one-third of the depth of slabs or three-fourths of the minimum clear distance between reinforcing bars or between bars and forms, whichever is least. In Precast columns the nominal maximum size of the aggregate shall be limited as above but shall not be larger than two-thirds of the minimum clear distance between bars.

4.1.7 Coarse aggregates in Precast concrete of normal weight may be of one maximum size for all concrete placed in 1 day when quantities to be placed are too small to permit economical use of more than one mix design.

When a single mix design is so used, the maximum nominal size shall be as required for the most critical condition of concreting, in accordance with the requirements of clause (4.1.6) above.

4.1.8 Except where it can be shown to the satisfaction of the Engineer that a supply of properly graded aggregate of uniform quality can be maintained over the period of the work, the grading of the aggregates shall be controlled by obtaining the 3/4" maximum nominal size, the different sizes being stocked in separate stock piles and recombined in the correct proportion for each batch at the batching plant. The materials shall be stock-piled for a period before use so as to drain nearly to constant moisture content (as long as site and other conditions permit, preferably for at least a day). The grading of the coarse and fine aggregates shall be tested at least once for every 100 tons supplied, to ensure that the grading is uniform and same as that of the samples used in the preliminary tests.

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

4.2 Cement

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

- Ordinary or Rapid Hardening Portland cements complying with the requirements of PS 232 or BS 12 or ASTM C 150.

- Sulphate Resisting Portland/Cement complying with the requirements of PS 612 or BS 4027 or ASTM C 150.

4.2.2 Unless otherwise specified, ordinary Portland cement complying with the requirements of BS 12 shall be used.

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

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

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

4.2.6 There shall be sufficient cement at site to ensure that each section of work is completed without interruption.

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

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

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

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

4.3 Water

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

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

4.4 Additive

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

Air Entraining Admixtures shall conform to ASTM C 260. Other Admixtures shall conform to ASTM C 494.

5. NOMINAL CONCRETE MIXES

5.1 Proportions of Mix

5.1.1 Cement and aggregates:

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

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

5.1.3 Water/Cement ratio:

The quantity of water used shall be just sufficient to produce a dense concrete of adequate strength and workability for its purpose. For all external work and foundations the water/cement ratio should not exceed 0.55 for concrete Class A, B and C.

5.1.4 Workability:

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

'Workability' shall be determined by either the slump or compaction factor tests as directed by the Engineer and these shall be performed in accordance with the methods given in PS 422 to PS 177 or ASTM C 143.

The slump or compaction factor for each class of concrete shall be determined during the preliminary Test mixes and the value obtained shall not be modified without the written consent of the Engineer. Unless otherwise permitted or specified, the concrete shall be proportioned and produced to have a slump of 3 inch or less for consolidation by vibration. A tolerance of upto 1 inch above the indicated maximum shall be allowed for individual batches provided the average for all batches or the most recent 10 batches tested, which ever is fewer, does not exceed the maximum limit. Concrete of lower than usual slump may be used provided it is properly placed and consolidated.

5.2 Strength requirements for concrete

5.2.1 Portland cement concrete when aggregates comply with BS 882.

5.2.2 Concrete made with Portland cement shall comply with the strength requirements of Table 1, columns 4&6 (Works Test).

Table 1: Strength requirements for Portland concrete with aggregates complying with BS. 882.

Class of Concrete (kg)	Nominal Design Mix	Min Cement per Cu.ft of compacted concrete (lb.)	Cube strength at 28 days after mixing & pouring (psi)		Alternative Cube strength at 7 days after mixing & pouring (psi)		Maximum water consumption per 110 lb. bag of cement (gallon)
			Preliminary tests	Works tests	Preliminary tests	Works tests	
1	2	3	4	5	6	7	8
A	1:1:2	30.00	5800	4350	3875	2900	4.40
B	1:1-1/2:3	22.00	4900	3750	3300	2450	5.06
C	1:2:4	18.00	4000	3000	2700	2000	5.28
D	1:3:6	13.00	2000	1550	1350	1000	7.05
E	1:4:8	9.50	------	1000	------		7.27

Note: Conversion Factors. 1 psi = 0.006897 MPa 1 gal = 4.54 liter
1 lb. = 0.4537 Kg.
1cu.ft. = 0.028 cum.

5.2.3 The strengths given in Table 1 are based on the assumption that average temperature is 20 degree C. Where accurate records of temperature are kept, allowance may be made for change of temperature or the cubes may be tested at the equivalent maturity.

5.2.4 All structural concrete shall conform to BS 5328.

5.2.5 Unless otherwise stated, the types of concrete shall be classified on the basis of compressive strength requirements. The Contractor shall provide Mix design by weight for each class of concrete.

Manufacture 12 test cubes for each 3 mix design batches (6 x 6 x 6) inches in accordance with the Mix design batching by weight and test 3 cubes each at 3,7,14 & 28 days intervals in the presence of Engineer's Representative and submit all relevant data and results of tests for approval of the Engineer. The Contractor shall obtain approval from the Engineer in writing for each Mix design before producing the actual concrete for the Works.

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

5.3 **Batching**

5.3.1 All cement, including cement supplied in bulk, shall be batched by weight. A bag of cement may be taken as weighing 110 lb. with the prior approval of the Engineer.

5.3.2 Aggregates shall be batched by weight, due allowance being made for water content. Aggregates may be batched by volume through conversion of weigh batching, only with the prior permission of the Engineer. The apparatus for weight-batching may be an integral part of the mixer or a separate unit of a type approved by the Engineer. It shall be accurate within 2% and shall be checked for accuracy at least once a week.

5.3.3 The quantity of additives i.e. foaming and water proofing agents etc. shall be as prescribed by the manufacturer or as directed by the Engineer.

5.3.4 Where the batching plant is of the type in which cement and aggregates are weighed in the same compartment, the cement shall be introduced into the compartment between two sizes of aggregates.

5.3.5 Each batch shall be so charged into the mixer that some water will enter in advance of the cement and aggregates. Water shall continue to flow for a period which may extend to the end of the first 25 percent of the specified mixing time. Controls shall be provided to prevent batched ingredients from entering the mixer before the previous batch has been completely discharged.

5.4 **Mixing**

5.4.1 The concrete shall be mixed in an approved batch mixer conforming to the requirements of BS 1305. It shall be fitted with the manufacturer's plate stating the rates, capacity and the recommended number of revolutions per minute and shall be operated in accordance therewith. It shall be equipped with a suitable charging mechanism and an accurate water measuring device. The mixer shall be capable of thoroughly combining the aggregates, cement and water into a uniform mass within the specified mixing time and of discharging the concrete without harmful segregation.

5.4.2 Mixing shall continue for the period recommended by the mixer manufacturer or until there is apparently a uniform distribution of the materials and the mass is

uniform in colour, whichever period is longer. If it is desired to use a mixing period of less than 1-1/2 minutes, the Engineer's approval shall be obtained in writing.

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

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

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

5.5 **Transporting**

5.5.1 The concrete shall be transported from the place of mixing to the place of final deposit as rapidly as practicable by means which will prevent segregation or loss of ingredients. All skip vehicles, or containers used for transporting the concrete shall be thoroughly cleaned.

5.5.2 During hot or cold weather, concrete shall be transported in deep containers, on account of their lower ratios of surface area to mass, which reduces the rate of loss of water by evaporation during hot weather and loss of heat during cold weather.

5.6 **Placing**

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

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

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

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

5.6.4 The concrete after it has been mixed shall be placed as soon as it is practicable. Once the concrete has left the mixer, no more water shall be added, although the concrete may be mixed or agitated to help maintain workability. The concrete shall not be used if, through any cause, the workability of the mix at the time of placing is too low for it to be compacted fully and to an acceptable finish by whatever means available.

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

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

5.6.5 Concrete shall be deposited as nearly as possible in its final position to avoid segregation due to re-handling or flowing. In no circumstances may concrete be railed or made to flow along the forms by the use of vibrators.

Concreting shall be carried on as a continuous operation using methods which shall prevent segregation or loss of ingredients.

5.6.6 The free fall of concrete shall not be allowed to exceed 6 feet. Where it is necessary for the concrete to be lowered more than this depth, it is not to be dropped into its final position, but shall be placed through pipes fed by a hopper. When a pipe is used for placing concrete the lower end shall be kept inside or close to the freshly deposited concrete. The size of the pipe shall be not less than 9 inch in diameter.

5.6.7 'Mass-concrete' shall be placed in layers approximately 18 inch thick. Vibrator heads shall extend into the previously placed layer.

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

5.6.9 Prior to the laying of concrete on load bearing masonry walls, bearing plates and at other points, as may be directed by the Engineer, the surface will be brought to a true, hard and smooth level surface using cement sand mortar in the ratio of 1 volume of cement to 3 volumes of sand. Two layers of building paper weighing .082 lb./ft^2 will then be laid flat to separate the concrete from the surface on which it is to be laid.

5.7 **Construction Joints**

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

5.7.2 Joints not shown on the drawings shall be so made and located as to least impair the strength of the structure and shall need prior approval of the Engineer. In general, they shall be located near the middle of the spans of slabs and beams unless a secondary beam intersects a main beam at this point, in which case the joint in the main beam shall be offset a distance equal to twice the width of the secondary beam. Joints in walls and columns shall be at the underside of floors, slabs or beams and at the top of footings or floor slabs. Beams, brackets, columns capitals, haunches and drop panels shall be placed at the same time as slabs. Joints shall be perpendicular to the main reinforcement.

5.7.3 All reinforcing steel shall be continued across joints. Keys and inclined dowels shall be provided as directed by the Engineer. Longitudinal keys at least 1-1/2 inches deep shall be provided in all joints in walls and between walls and slabs or footings.

5.7.4 When the work has to be resumed on a surface which has hardened, such surface shall be roughened in an approved manner which will expose the

aggregate uniformly and will not leave laitance, loosened particles of aggregate or damaged concrete at the surface.

5.7.5 The hardened concrete of construction joints and of joints between footings and walls or columns, between walls or columns and beams or floors they support, joints in un-exposed walls and all others not mentioned herein shall be dampened (but not saturated) immediately prior to placing of fresh concrete.

5.7.6 The hardened concrete of joints in exposed work, joints in the middle of beams, and slabs; and joints in work designed to contain liquids shall be dampened (but not saturated) and then thoroughly covered with a coat of cement grout similar in proportions to the mortar in the concrete. The grout shall be as thick as possible on vertical surfaces and at least 1/2 inch thick on horizontal surfaces. The fresh concrete shall be placed before the grout has attained initial set.

5.7.7 Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle, and brushed, care being taken to avoid dislodgment of particles of aggregate. The surface shall then be coated with neat cement grout. The first layer of concrete to be placed on this surface shall not exceed 6 inch in thickness, and shall be well rammed against old work, particular attention being paid to corners and closed spots.

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

5.8 **Expansion Joints**

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

All expansion joints shall be carefully placed so as not to be displaced during concreting. The method of placing the expansion joints shall be strictly in accordance with the Drawings and/or as directed by the Engineer. All materials for use in the expansion joints shall have prior approval of the Engineer before placing order for supply.

5.9 **Embedded Items**

5.9.1 The material, design and location of water-stops in joints shall be as indicated in the Contract Documents. Each piece of pre-molded water stop shall be of maximum practicable length in order that the number of end joints will be held to a minimum.

Joints at intersections and at ends of pieces shall be made in the manner most appropriate to the material being used. Joints shall develop effective water-tightness fully equal to that of the continuous water-stop material, shall permanently develop not less than 50 percent of the mechanical strength of the parent section and shall permanently retain their flexibility.

5.9.2 Electric conduits and other pipes which are planned to be embedded shall not, with their fittings, displace more than four percent of the area of the cross section of a column on which stress is calculated or which is required for fire protection. Sleeves, conduits, or other pipes passing through floors, walls, or beams shall be of such size or in such location as not to impair unduly the strength of the construction; such sleeves, conduits, or pipes may be considered as replacing structurally in compression the displaced concrete,

provided that they are not exposed to rusting or other deterioration, are of uncoated or galvanized iron or steel not thinner than standard steel pipe, have a nominal inside diameter not over 2 inch and are spaced not less than three diameters on centers. Except when plans of conduits and pipes are approved by the Engineer, embedded pipes and conduits other than those merely passing through, shall not be larger in outside diameter than one third the thickness of the slab, wall, or beams in which they are embedded nor so located as to impair unduly the strength of the construction. Sleeve pipes, or conduits of any material not harmful to concrete and within the limitations of this section may be embedded in concrete with the approval of the Engineer provided they are not considered to replace the displaced concrete.

5.9.3 All sleeves, inserts, anchors, and embedded items required for adjoining work or for its support shall be placed prior to concreting.

All Contractors whose work is related to the concrete or must be supported by it shall be given ample notice and opportunity to introduce and/or furnish embedded items before the concrete is placed.

5.9.4 Expansion joint material, water-stops and other embedded items shall be positioned accurately and supported against displacement. Voids in sleeves, inserts and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids.

5.10 **Pre-Cast Concrete**

Pre-cast concrete units shall be fair faced (OR WITH ARCHITECTURAL FINISH or with an approved pattern finish) cast to the sizes and dimensions as indicated on the Drawings. The concrete used for pre-cast units shall conform to the specifications laid down for cast in situ reinforced cement concrete unless otherwise required and directed by the Engineer.

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

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

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

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

5.10.1 Erecting Pre-cast Units

All the pre-cast units shall be transported and erected into position in a manner as approved by the Engineer.

The Contractor shall submit his proposal in this regard and obtain approval from the Engineer in advance.

5.10.2 Lifting Beams

The Contractor shall use lifting beams at his own cost for erecting pre-cast members where the Engineer so directs. Lifting beams shall be supplied and erected by the Contractor, at his own cost, at all points where lifting is necessary for maintaining the plant but is inaccessible to mobile cranes or, alternatively, covered by overhead traveling cranes. The Contractor, however, is to supply the trolleys and erect them on the lifting beams, and to test operation of installed equipment.

5.11 **Cement Concrete Pavements**

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

5.11.1 Side Forms and Construction

Side forms shall be of steel or any other suitable material and of a design as approved by the Engineer.

In general, only materials and methods that have proved their acceptability by past performance will be considered. All form shall be constructed so that they can be removed without hammering or prying against the concrete.

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

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

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

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

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

5.11.2 Protection and Curing

- General Requirements:

  Concrete shall be protected adequately from injurious action by sun, rain, flowing water and mechanical injury, and shall not be allowed to dry form the time it is placed until the expiry of the minimum curing periods specified hereinafter. Water curing shall be accomplished by keeping the surface of the concrete continuously wet by covering with water or with an approved water saturated covering. Where wood forms are left in place for curing, they shall be kept sufficiently damp at all times to prevent openings at the joints and drying out of the concrete. All portions of the structure shall be kept moist for the full curing periods, specified hereinafter.

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

- Curing Periods

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

- Removal of Forms

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

5.11.3 Finishing

All unformed surfaces shall be finished with a wood float except as otherwise specified. Visible vertical surfaces shall have all projections and irregularities removed. The entire surface shall be rubbed if required by the Engineer, with a No. 16 carborundum brick, or other abrasive until even, smooth and of uniform appearance, and shall be shed clean. Plastering of surface, application of cement or other coating will not be permitted.
All exposed corners shall be chamfered, 1"x 1" (2.5 cms x 2.5 cms) unless otherwise mentioned or shown on the plans or directed by the Engineer. Concrete surfaces which will be covered with other materials shall be screeded without floating.

5.11.4 Spreading, finishing and floating of concrete in pavements

- General Requirements

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

- Mechanical Methods

The concrete shall be spread uniformly between the forms, immediately after it is placed, by means of an approved spreading machine. The spreader shall be followed by an approved finishing machine equipped with two oscillating or reciprocating screeds. The spreading machine or the finishing machine shall be equipped with vibrating equipment that will vibrate the concrete for the full paving width. Internal vibrators shall be used adjacent to the longitudinal edge of the pavement. These vibrators shall be attached to the rear of the spreading machine or to the finishing machine. Vibrators shall not rest on view pavements or side forms or in contract with any dowel bars and the arrangement of power supply to the vibrators shall be such that when the motion of machine is stopped, vibration shall cease. The rate of vibration shall be not less than 8000 vibrations per minute. The concrete shall be spread to full width before being struck off and compacted so that the surface will conform to the finished grade and cross-section as shown on the plans and at the same time leave sufficient material for the floating operation. The spreading & finishing machine shall move over the pavement as many times and at such intervals as may be required by the Engineer to ensure thorough compaction.

Except as otherwise specified, after the pavement has been struck off and compacted, if shall be finished with an approved longitudinal float. The Contractor may use a longitudinal float composed of one or more cutting and smoothing floats, suspended from and guided by rigid frame. The frame shall be carried by four or more visible wheels riding on and constantly in contact with the forms.
The contractor may use a longitudinal float which works with a sawing motion, while held in a floating position parallel to the road centre line and passing gradually from one side of the pavement to the other. Movements ahead, along the centre line of the road, shall be in successive advances of not more than half the length of the float.

Instead of using other type of longitudinal float a single machine which will affect satisfactory compaction, finishing and floating may be used. This machine may be towed by a spreading machine. This combination, finishing floating machine shall be equipped with screeds and vibrators as hereinafter specified for spreading and finishing machine. Floating shall be accomplished by means of a non-oscillating float held in a suspended position form the frame.

If any spreading, finishing and floating equipment is not maintained in full working order or if the equipment as used by the Contractor proves inadequate to obtain the results prescribed, such equipment shall be improved or satisfactory equipment substituted or added at the direction of the Engineer.

- Manual Methods

When striking-off and compacting by manual methods is permitted, the concrete shall be leveled and then struck-off to such an elevation that, when properly compacted, the surface will conform to the required grade and cross-section. The strike board shall be moved forward with a combined longitudinal and transverse motion, the manipulation being such that neither end is raised from the side forms during the process. While striking off, a slight excess of concrete shall be kept in front of the cutting edge at all times. Prior to tamping, the concrete along the forms shall be thoroughly spaded or vibrated. The entire area of pavement shall be tamped or vibrated a manner that will ensure maximum compaction. The concrete shall be brought to the required grade and shape by the use of a tamper consisting of a heavy plank whose length exceeds the width of the pavement by 1 foot or by the use of a mechanical vibrating unit spanning the full width of the spread. The

tamper shall be constructed with properly trussed roads to stiffen it and prevent sag and shall be shod with a heavy strip or metal for a tamping surface. The tamper shall be moved with a combined tamping and longitudinal motion, raising it form side form and dropping it so that the concrete will be thoroughly compacted and rammed into place. A small surplus material is compacted and rammed into front of the tamper or vibrating unit and tamping or vibrating shall continue until the true cross-section is obtained and the mortar flushes slightly to the surface.

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

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

- Longitudinal Floating

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

- First Straight Edge Testing

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

- Burlap (Coarse Canvas) Dragging

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

- Second Straight Edge Testing

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

5.11.5 Expansion and Contraction Joints

i. All the expansion and contraction joints shall be carefully formed as shown on the Drawings or as directed by the Engineer. As regards dowel bars and joint assemblies, such stakes, brackets or other devices shall be used, as necessary to keep the entire joint assembly in true vertical and horizontal position. The joint filler together with the

preformed groove shall provide complete separation of adjacent slabs. The joints shall all be sealed with the specified non-extruding sealing compound set in a 3/4 inch wide preformed chase as shown on the Drawings. The preformed chase shall be thoroughly cleaned of all dust, debris, stones or other hard material prior to its sealing. The riser of all joints shall be rounded to a radius as shown on the Drawings before the concrete hardens.

ii The joints sealing compound shall be hot poured bitumen or approved sealing compound for concrete pavements complying with BS-2499 for hot tropical climates and heavy duty industrial site subject to severe exposure. All joints are to be filled with flexcell expansion joint filler, or an approved elastic, compressible, durable and rot-proof equivalent of sufficient rigidity to enable it to be satisfactorily installed in the joint and resist deformation during the passage of the concreting equipment. The filler is to be of the same thickness as the joint width. Holes to accommodate the dowel bars shall accurately be drilled or punched out. Where shown on the Drawings, dowel bars of required diameter shall be placed at the specified spacing. The bars shall be lubricated with an approved lubricant. One end of the dowel bar at expansion joints shall be provided with a closely fitting sleeve 3 inch long, consisting of bitumen coated plastic or other approved material to permit expansion. A loose plug 1 inch deep of approved compressible filling material shall be inserted into the sleeve as shown on the Drawings at the end of the bar. All the dowel bars shall be mild steel bars of the size shown on the Drawings and shall conform to the requirements as specified in the section 'Concrete.

iii Contraction joints shall be provided as shown on the Drawings.

The assembly and method of constructing the expansion joints/contraction joints shall be subject to the approval of the Engineer.

5.12 **Consolidation**

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

Where the concrete is to have an as-cast finish, a full surface of mortar shall be brought against the form by the vibration process, supplemented, if necessary, by spading to work the coarse aggregate back from the formed surface.

5.12.2 If there is any tendency for the mix to segregate during consolidation, particularly if this produces excessive laitance, the mix proportions shall be modified to effect an improvement in the quality of the concrete to the satisfaction of the Engineer and in conformity with the provisions of Clause 5.

5.12.3 Vibrator shall not be allowed to contact the form work for exposed concrete surfaces.

5.12.4 Mechanical vibrators shall be of a type suited in the opinion of the Engineer to the particular conditions.

5.12.5 Over-vibration or vibration of very wet mixes is harmful and should be avoided.

5.13 **Curing and Protection**

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

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

- Ponding or continuous sprinkling.
- Application of absorptive mats or fabric kept continuously wet.
- Application of waterproof sheet materials approved by the Engineer.
- Application of other moisture-retaining covering as approved.
- Application of a curing compound conforming to ASTM C 309.

The compound shall be applied in accordance with the recommendations of the manufacturer immediately after any water sheen which may develop after finishing has disappeared from the concrete surface. It shall not be used on any surface against which additional concrete or other material is to be bonded unless it is proved that the curing compound will not prevent bond, or unless positive measures are taken to remove it completely from areas to receive bonded applications.

5.13.3 Moisture loss from surfaces placed against wooden forms or metal forms exposed to heating by the sun shall be minimized by keeping the forms wet until they can be safely removed. After form removal the concrete shall be cured until the end of the time prescribed for curing.

5.13.4 Curing in accordance with sub-clause 5.13.1 & 5.13.2 above shall be continued for at least 10 days in the case of all concrete except concrete with rapid-hardening Portland Cement for which the period shall be at least 3 days. Alternatively, if tests are made of cubes kept adjacent to the structure and cured by the same methods, moisture retention measures may be terminated when the average compressive strength has reached 70 percent of the minimum specified works cube strength. If one of the first four curing procedures of sub-clause 5.13.2 is used initially, it may be replaced by one of the other procedures of that sub-clause any time after the concrete is one day old provided the concrete is not permitted to become surface dry during the transition.

5.13.5 When the mean daily outdoor temperature is less than 5 degree C (41 deg. F) temperature of the concrete shall be maintained between 10 and 20 degrees C (50 to 68 deg. F) for the required curing period of sub-clause 5.13.4.

When necessary, arrangements for heating, covering insulation or housing the concrete work shall be made in advance of placement and shall be adequate to maintain the required temperature without injury due to concentration of heat. Combustion heaters shall not be used during the first 24 hours unless precautions are taken to prevent exposure of the concrete to exhaust gasses which contain carbon dioxide.

5.13.6 During hot weather when necessary, provision for wind-brakes, shading for spraying, sprinkling, ponding or wet covering with a light coloured material shall be made in advance of placement. Such protective measures shall be taken as quickly as concrete hardening and finishing operation will allow.

5.13.7 Changes in temperature of the air immediately adjacent to the concrete during and immediately following the curing period shall be kept as uniform as possible and shall not exceed 3 deg. C (37 deg. F) in any one hour or 10 degree C (50 deg. F)in any 24 hour period.

5.13.8 During the curing period, the concrete shall be protected from damaging mechanical disturbances, such as load stresses, heavy shock and excessive vibrations. All finished concrete surfaces shall be protected from damage by construction equipment, materials or methods by application of curing procedures, and by rain or running water. Self-supporting structures shall not be loaded in such a way as to over stress the concrete.

5.14 **Works in Extreme Weather**

5.14.1 Unless adequate protection is provided and approval is obtained from the Engineer, concrete shall not be placed during rain.

Rain water shall not be allowed to increase the mixing water nor to damage the surface finish.

5.14.2 When the temperature of the surrounding air is expected to be below 5 deg. C during placing or within 24 hours thereafter, the temperature of the plastic concrete, as placed, shall be no lower than 13 deg. C for sections less than 12 inch in any dimension nor 10 deg. C for any other sections.

When necessary, concrete material should be heated before mixing and carefully protected after placing, in general, heating or mixing water alone to about 60 deg. C may be sufficient for this purpose. Dependence should not be placed on salt or other chemicals for the prevention of freezing. No frozen material or materials, containing ice shall be used. All concrete damaged by frost shall be removed. It is recommended that concrete exposed to the action of freezing weather should have entrained air and the water content of the mix should not exceed 5.5 gallon/bag of cement.

If water or aggregate is heated above 38 deg. C the water shall be combined with the aggregate in the mixer before cement is added. Cement shall not be mixed with water or with mixtures of water and aggregate having a temperature greater than 38 deg. C.

5.14.3 During hot weather, the temperature of the concrete as placed shall not be so high as to cause difficulty from loss of slump, flash set, or cold joints and should not exceed 32 deg. C. For massive concrete, this temp. should not exceed 21 degree C. When the temp. of the concrete exceeds 32 degree C, precautionary measures approved by the Engineer shall be put into effect. When the temperature of the steel is greater than 50 deg. C, steel forms and reinforcement shall be sprayed with water just prior to placing the concrete. The ingredients shall be cooled before mixing, or flaked ice or well crushed ice of a size that will melt completely during mixing may be substituted for all part of the mixing water if, due to high temperature, low slump, flash set or cold joints are encountered.

Other precautions recommended by ACI Standard 305-72 shall also be adopted.

6. TEST OF CONCRETE QUALITY

6.1 The Contractor shall provide samples of concrete for testing at the Engineer's direction. Proper facilities shall be provided for making and curing the test specimens in

accordance with PS 560 and PS 849. A competent person shall be employed by the Contractor whose first duty shall be to supervise all stages in the preparation and placing of the concrete. All test specimens shall be made and site tests carried out under his direct supervision.

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

6.3 The usual test for concrete with maximum size of aggregate upto 1-1/2 inch is the 6 inch cube tested in compression. Details of making and curing compression test cubes are given in PS 560, PS 849 and BS 1881 and details of the testing are given in Part 8 of BS 1881.

6.4 For all grades of concrete, preliminary cube strength test with the mixes and materials to be used shall be performed in accordance with PS 560, PS 849 and BS 1881 before the work is begun and subsequently whenever any change is to be made in the materials or in the proportions of materials to be used, or as required by the Engineer. The strengths shall comply with the standard of quality specified in accordance with Table 1 for preliminary tests. The cost of such testing shall be borne by the Contractor.

6.5 Test sample shall be taken at the mixer or as directed by the Engineer. The test specimens shall be cured in accordance with PS 560, PS 849 and BS 1881.

Records shall be kept of all test cubes identifying the mix used, the section of work for which the concrete was used and the date poured.

6.6 Five test cubes are to be tested for compressive strength as specified in BS 1881. These tests shall be carried out at site or in a laboratory approved by the Engineer. Two cubes shall be tested at the age of seven days and three at 28 days and the strengths determined are to comply with the standard of quality specified. The laboratory tests shall be carried out by an independent organization, such as Government Testing Laboratory or such other undertakings approved by the Engineer. The original test reports received from the above authorities should be submitted to the Engineer.

6.7 For all grades of concrete, the appropriate strength requirement shall be considered to be satisfied if none of the strengths of the cubes is below the specified cube strength or if the average strength of the three cubes is not less than the specified cube strength and the difference between the greatest and the least strength is not more than 20% of the average.

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

7. FINISHING OF FORMED SURFACES

7.1 General

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

7.1.2 When finishing is required to match a small sample furnished to the Contractor, the sample finish shall be reproduced on an area at least 100 Sq. ft. in an inconspicuous location designated by the Engineer before proceeding with the finish in the specified location.

7.1.3 Allowable deviations from plumb or level and from the alignment, profile grades, and dimensions are specified in clause 9. Tolerances for concrete construction and defined as tolerances that are to be distinguished from irregularities in finish as described herein. The finish requirements for concrete surfaces shall be as generally specified in this clause and as indicated on the Drawings. Finishing of concrete surfaces shall be performed only by workmen who are skilled in concrete finishes. The Contractor shall keep the Engineer advised as to when finishing of concrete will be performed. Unless inspection is waived in each specific case, finishing of concrete shall be performed only in the presence of the Engineer. Concrete surfaces will be tested by the Engineer where necessary to determine whether surface irregularities are within the limits herein after specified. Surface irregularities are classified as abrupt or gradual.

Offsets caused by displaced or misplaced form sheeting or lining or sections, or otherwise defective form lumber will be considered as abrupt irregularities, and will be tested by direct measurements. All other irregularities will be considered as gradual irregularities, and will be tested by use of a template, consisting of a straight edge or the equivalent thereof for curved surfaces. The length of the template will be 6.5 ft. for testing of formed surfaces and 10 ft. for testing of unformed surfaces.

7.2 **As-cast Finishes**

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

7.2.1 Rough form finish:

No selected form facing materials shall be specified for rough form finish surfaces. Tie holes and defects shall be patched. Fins exceeding 1/4" in height shall be chipped off or rubbed off. Otherwise, surfaces shall be left with the texture imparted by the forms.

7.2.2 Fair face finish:

Fair face finish applies to concrete formed surfaces, the appearance of which is considered by the Engineer to be of special importance, such as surfaces of structures prominently exposed to public inspection. Surfaces of concrete structures requiring fair face finish is shown in the Drawings. Surface irregularities, measured as described in sub-clause 7.2.1, 'Rough form finish', shall not exceed 1/4 inch for gradual irregularities and 1/8 inch for abrupt irregularities, except that abrupt irregularities will not be permitted at construction joints. Abrupt irregularities at construction joints and elsewhere in excess of 1/8 inch and gradual irregularities in excess of 1/4 inch shall be reduced by grinding so as to conform to the specified limits. Abrupt irregularities at construction joints shall be ground on level of 1 to 20 ratio of height to length.

Unless otherwise approved, repair of imperfections in formed concrete shall be completed within 24 hours after removal of forms. The form facing material shall produce a smooth, hard, uniform texture on the concrete. It may be plywood, temperated concrete-form-grade hardboard, metal, plastic paper or other approved material capable of producing the desired fair face finish. The arrangement of the facing material shall be orderly and symmetrical, with the number of seams kept to the practical minimum. It shall be supported by studs or other backing capable of preventing excessive deflection. Material with raised grain, torn surfaces, worn edge, patches, dents, or other defects which will impair the texture of the concrete surface shall not be used. Tie holes and defects shall be patched. All fins shall be completely removed.

7.2.3 Architectural Finish Concrete:

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

Samples:

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

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

Sample approvals of Precast & in-situ concrete:

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

Forms

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

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

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

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

Curing:

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

Finishing procedures:

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

While the concrete surface is still damp (not more than three days after removal of forms), apply a thin coat of medium consistency neat cement slurry by means of bristle brushes to provide a bonding coat within any pits or blemishes in the parent concrete; avoid coating large areas of the finished surface. Before slurry has dried or changed colour, apply a dry (almost crumbly) grout comprised of one part cement, of the type and brand of cement used in the original concrete, to one and one-half parts clean masonry sand with a fineness modulus of approximately 2.25 and complying with the gradation requirements

of the ASTM Specifications C 144. Mix proper amounts of white cement and colouring with the parent mortar to produce a satisfactory colour match with the parent concrete after hardening. Use samples previously prepared.

Apply the finishing grout uniformly with damp (neither dripping wet nor dry) pads of coarse burlap approximately 6 inch square used as a float. Scrub the grout well into the pits to provide a dense mortar in all the imperfections to be filled. Allow the mortar to partially harden, from one to two hours, depending upon the weather. Avoid direct hot sunlight. If the air is hot and dry, keep the concrete surface damp during this period using a fine fog spray. When the grout has hardened sufficiently so it can be scraped from the surface with the edge of a steel trowel without damaging the grout from the small pits of holes, cut off all that can be removed with a trowel without delay; next allow the surface to dry thoroughly and rub it vigorously with clean, dry burlap to completely remove any dried grout. No visible film of grout shall remain after this rubbing. Complete the entire cleaning and grouting operation for the grout to dry after it has been cut with the trowel, so it can be wiped off clean with the burlap.

On the day after the repair work, the concrete surfaces should again be wiped off clean with dry burlap to remove any inadvertent dust; leave no built-up surfaces on the parent surfaces. Employ, if possible, a used piece of burlap containing old hardened mortar to act as a mild abrasive. Use of fine abrasive stone if needed to remove any remaining built-up film without breaking through the surface film of the original concrete. Such scrubbing should be light and sufficient only to remove excess material without working up a lather of mortar or changing the texture of concrete.

Following the final bagging or stoning operation, provide a thorough wash down with stiff bristle brushes to remove all extraneous materials and spray the concrete surface with a fine fog spray periodically to maintain a continually damp condition for at least three days after application of the pit repair grout.

Rust Stains:

All rust stains are to be removed employing the following procedure:

The rust stain shall be soaked for 10 minutes with a solution of 0.055 lb. of sodium citrate in 0.33 lb. water (brushing the solution at short intervals is satisfactory). Then the surface is sprinkled with crystals of sodium hydrosulfite and covered with a paste of Fuller's Earth and water. On a vertical surface, the paste is applied with a trowel, with the crystals first sprinkled on the paste so they will be in direct contact with the stain. The paste is allowed to dry for 10 minutes then scraped off and the treatment repeated if necessary.

Repairing of Formed Surfaces:

It is the intention of Specification to require forms, mixture of concrete and workmanship so that concrete surfaces, when exposed, will require no patching. Any concrete which is not formed as required and conforming to approved samples or for any reason is out of alignment or level or shows a defective surface, shall be removed from the job by the Contractor at his expense unless the Engineer grants permission to repair the defective area. Permission to patch any such area shall not be considered a waiver of the Engineer's right to require a complete removal of defective work if the repair does not, in his opinion, satisfactorily restore the quality and appearance of the surface. The Engineer shall be the sole judge of acceptability of appearance.

7.3 **Finishes of Unformed Surfaces:**

7.3.1 Monolithic Concrete Floor Finish'

Where monolithic concrete floor finish is shown on the Drawings, placing shall proceed continuously for the full thickness of the course or RCC slab without change in concrete mix. Mixing water shall be the minimum required for proper placing, and will be as specified by the Engineer. After placing, floors, and other surfaces shall be floated with a wood float to a true surface and to elevation as shown on the Drawings. Where indicated on the Drawings, floor surfaces shall be steel trowel finished. Toweling shall be the minimum amount consistent with maintaining a smooth dense surface, and shall not be done until the mortar has hardened sufficiently, to prevent excess fine material from being worked to the surface, and shall produce a dense uniform surface, free from blemishes and trowel marks.

Gradual surface irregularities shall not exceed 1/16 inch. The addition of water, dry cement, or dry cement mortar, to the surface of the concrete to facilitate finishing will not be permitted.

7.3.2 Equipment Foundations'

Unless otherwise specified, exposed, surfaces of equipment foundations shall be given steel trowel finish to produce a surface similar to the specified concrete floor finish.

8. REPAIR OF SURFACE DEFECTS

8.1 **General**

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

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

8.2 **Repair of Defective Areas**

8.2.1 All honeycombed and other defective concrete shall be removed down to sound concrete. The area to be patched and an area at least 6 inch wide surrounding it shall be dampened to prevent absorption of water from the patching mortar. A bonding grout shall be prepared using a mix of approximately 1 part cement to 1 part fine sand passing No.25 BS Sieve and shall then be well brushed into the surface.

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

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

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

8.2.5 Where as-cast finishes are specified, the quantity of patched area shall be strictly limited. The combined total of patched areas in as-cast surfaces shall not exceed 2 sq.ft. in each 1000 sq.ft. of as-cast surface. This is in addition to form tie patches, if the project design permits ties to fall within as-cast areas.

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

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

8.3 Tie and Bolt Holes

After being cleaned and thoroughly dampened, the tie and bolt holes shall be filled solid with patching mortar. If architectural appearance requires, these holes may be filled partially creating the desired round clear holes pattern on surfaces exposed to view.

8.4 Proprietary Materials

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

9. CONCRETE CONSTRUCTION TOLERANCES

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

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

9.1.1 In the lines and surfaces of columns, piers, walls and in arrises:

In any 10 feet of length or height	1/4 inch
In any storey or 20 feet length	3/8 inch
Maximum for the entire length or height.	1 inch

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

In any bay or 20 feet maximum	1/4 inch
Maximum for the entire length or height	1/2 inch

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

9.2.1 In floors, ceilings, beams soffits and in arrises measured before removal of supporting shores.

In any 10 feet of length	1/4 inch
In any bay or in any 20 feet length	3/8 inch
Maximum for the entire length	3/4 inch

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

In any bay or 20 feet length	1/4 inch
Maximum for the entire length	1/2 inch

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

In any bay or 20 feet of length	1/2 inch
Maximum for the entire length	1 inch

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

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

Minus	1/4 inch
Plus	1/2 inch

9.6 **Footings**

9.6.1 Variation in dimensions in plan

Minus	1/2 inch
Plus (plus variation applied to concrete only, not to reinforcing bars or dowels).	2 inch

9.6.2 Misplacement or eccentricity

2 percent of the footing width in the direction of misplacement but not more than (applies to concrete only, not to reinforcing bars or dowels).	2 inch

9.6.3 Thickness

Decrease in specified thickness	5%
Increase in specified thickness	No limit

9.7 **Variation in Steps**

9.7.1 In a flight of stairs

Rise	± 1/8 inch
Tread	± 1/4 inch

9.7.2 In consecutive steps

Rise	± 1/16 inch
Tread	± 1/8 inch

9.8 **'Tolerances for Precast concrete construction'**

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

9.8.1	Overall dimensions of members	1/16 inch per 10 feet
9.8.2	Cross-sectional dimensions	
	Sections less than 3 inch.	1/16 inch
	Sections over 3 inch and less than 18 inch.	1/8 inch
	Sections over 18 inch.	1/4 inch
9.8.3	Deviations from straight line in long sections.	
	Not more than	1/8 inch per 10 feet.
9.8.4	Deviation from specified camber	± 1/16 inch per 10 feet span.
	Maximum differential between adjacent units in erected position	1/4 inch.

10. ACCEPTANCE OF STRUCTURE

10.1 **General**

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

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

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

10.2 **Dimensional Tolerances**

10.2.1 Formed surfaces resulting in concrete outlines smaller than permitted by the tolerances of clause 9 shall be considered potentially deficient in strength and subject to the provisions of sub clause 10.4.

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

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

10.2.4 Inaccurately formed concrete surfaces exceeding the limits of Clause 9 or of Clause 5.6 of Section 'Formwork' and which are exposed to view, may be rejected and shall be repaired or removed and replaced if required.

10.3 **Appearance**

10.3.1 Architectural concrete with surface defects exceeding the limitations of Sub-clause 5.6 of Clause 5 of the Section, 'Formwork' shall be removed and replaced.

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

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

10.4 **Strength of Structure**

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

- Concrete strength requirements not considered to be satisfied in accordance with Clause 6 hereof.
- Reinforcing steel size, quantity, strength, position or arrangement at variance with the requirements as listed under specification of 'Reinforcement' or in the Contract Documents.
- Concrete which differs from the required dimensions or location in such a manner as to reduce the strength.
- Curing less than that specified.
- Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.
- Mechanical injury, construction fires, accidents of premature removal of formwork likely to result in deficient strength.
- Poor workmanship likely to result in deficient strength.

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

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

10.4.4 If core tests are inconclusive or impractical to obtain or if structural analysis does not confirm the safety of the structure, load tests may be required and their result evaluated in accordance with British Standard BS 8110 or ACI Standard 318.

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

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

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

11. PVC WATER STOP/HYDROFOIL

11.1 Material

All PVC water stops/hydrofoil shall be central bulb type from a manufacturer approved by the 'Engineer'. The specific gravity of PVC water stop/hydrofoil shall not be less than 1.37 and Full stretch Break cut intensity when tested at normal temperature shall not be less than 1875 psi.

The material shall have a modulus of rigidity of 850 psi at +10^{o} C and 10,500 psi at 20^{o} C.

11.2 Placing & Connections

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

After joining, the water stop should be allowed to cool.

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

12. NON-SHRINK GROUT:

Grout for placement under base and bearing plates of machinery and equipment, for grouting anchor bars and dowels and for similar uses shall be as follows:-

12.1 Composition

12.1.1 Non-shrink grout of less than 1 inch thickness shall consist of one part Portland cement and one part of clean sharp sand conforming to the requirements of these specifications and 1:22,000 to 1:15000 part of grained aluminum powder containing non polishing agent.

12.1.2 Non-shrink grout of 1 inch or more in thickness shall be proportioned as above except that 1-1/2 parts of 3/8 inch to 1/4 inch pea gravel shall be added.

12.1.3 The above specified composition may be varied if required by the Engineer. The Contractor shall, at his own cost, make optimum mix design and testing for approval of the composition.

12.1.4 Proportioning shall be done by weight.

12.1.5 Mixing water shall be proportioned so as to provide a flowable mixture without segregation or bleeding. Dry packing will not be permitted.

12.2 **Application**

12.2.1 Concrete surfaces to receive non-shrinking grout shall be roughened, cleaned and dampened.

12.2.2 Form shall be provided to retain the grout until sufficiently hard to support itself.

12.2.3 Grout shall be poured in place and thoroughly rodded or washed to prevent the formation of voids.

12.2.4 After non-shrink grout has received its initial set, it shall be kept damp for 24 hours.

12.3 **Non-Shrink Second Stage Concrete Grout**

Non-shrink second stage concrete grout shall be provided and placed in position where shown on the Drawings or as directed by the Engineer. Non-shrink concrete mix proportion shall be one part cement two parts coarse clean sand and four parts of coarse aggregates meeting the requirements of these specifications and 1:22,000 to 1:15000 part of grained aluminum powder containing non-polishing agent. Proportioning shall be done by weight.

The above specified composition may be varied if required by the Engineer.

The Contractor shall at his own cost make optimum mix design and testing for approval of the Engineer prior to commencement of the work.

Mixing water and application procedure shall be followed as given in sub-clause 12.2 or as per direction of the Engineer.

13. VAPOUR BARRIER

Vapour barrier shall be polyethylene building film, visqueen standard or approved equal. The film shall be 150 micron thick (100 gauge). The quality of material shall be approved by the Engineer prior to use in the works.

Vapour barrier shall be laid in position wherever shown on the Drawings.

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

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

14. 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 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.

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

14.1.2 Providing, placing and fixing of anchor bolts or any other embedded parts.

14.1.3 Providing and installing all type of joints in concrete structure, including expansion joints.

14.1.4 Providing and fixing water stoppers.

14.2 **Plain and Reinforced Concrete**

14.2.1 Measurement

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

- Volume of any steel embedded in the concrete.
- Volume occupied by water pipes, conduits etc. not exceeding 10 square inches each in cross-sectional area.
- Voids not exceeding 4 square inch in work given in square feet. If any void exceeds 4 square inch, total void shall be deducted.

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

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

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

Measurement of walls shall be taken between attached columns piers or pilaster. The thickness of attached columns, piers or pilaster shall be taken as the combined thickness of the wall and the columns, piers or pilaster.

Attached or isolated columns, piers, pilaster, and the like (except where caused by openings) having a length on plan not exceeding four times the thickness shall be classified as columns. Those having a length over four times the thickness and are caused by openings in wall shall be classified as walls.

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

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

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

14.2.2 Payment

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

14.3 Testing of Material

a) A site laboratory shall be established by the Contractor for all the required testing of concrete, aggregates and other materials etc. All tests shall preferably be done at site. Only the test which are not possible to be carried out in the site laboratory shall be referred to the laboratory approved by the Engineer. All testing charges thereof shall be borne by the Contractor.

For testing of reinforcement steel bars, the samples shall be referred to the laboratory approved by the Engineer at the cost of the Contractor.

b) Cement shall be tested as prescribed in ASTM C -150.

c) Aggregates shall be tested as prescribed in Brithish Standard BS 812 & 882. In addition fine aggregate shall be tested for organic impurities in conformance with ASTM Standard C.40.

14.4 **Vapour Barrier**

14.4.1 Measurement

Measurement of acceptably completed works of vapour barrier will be made on the basis of number of square feet provided and placed in position as shown on the Drawings or as directed by the Engineer.

14.4.2 Payment

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

End of Section 2300

SECTION - 3000

STRUCTURAL STEEL WORKS

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 MBG 531	Metal Bar Grating
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 ^{0} 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 encases/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 holts 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 a 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 or 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 form 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 - 4600

CARPENTRY AND JOINERY

SECTION - 4600

CARPENTRY AND JOINERY

1. SCOPE

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

2. MATERIALS

2.1 Timber

2.1.1 Hard Wood :

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

2.1.2 Soft Wood :

All soft wood shall consist of pines, spruce, hemlock and douglas fir or cedrous deodar (referred in the document as deodar), wood locally known as 'Partal' to be used in shutter core where specified.

2.1.3 General Characteristics :

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

The whole of the timber shall be from the heart of sound and fully grown tree, uniform in substance, straight in fibre, first class quality properly seasoned, free from large or loose dead-knots, open shakes and excessive sapwood. The scantlings of all timbers shall be bright, sound and square edged. The moisture content of timber shall not be more than 10 (ten) percent in case of soft wood and 7 (seven) percent in case of hard wood.

2.1.4 Preservation of Wood :

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

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

2.1.5 Adhesive :

The adhesives shall conform to the requirements of BSI No. 745 "Animal Glues for Wood" manufactured by M/s Hoest shall be considered approved for this Project or as directed and approved by the Engineer.

2.1.6 Nails and Screws :

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

2.2 Ply Wood

The ply wood shall comply in all respects with BSI No. 1455:1963. All the ply wood shall only be obtained from KDC Board (Pvt.) Limited, Jhelum as approved by the Engineer. All plywood shall be manufactured with phenol pharamaldihide or any other approved water proof adhesive but not with urea pharamaldihide.

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

2.3 Medium Density Fibre (MDF) Board

Medium density fibre board to be used on the project shall be LASANI of thicknesses as specified in the drawings. Board shall be manufactured with water proof resinous glues and shall be guaranteed by the manufacturer. All boards required for the exterior surfaces of cabinets shall be laminated with formica in approved colour and texture in factory as specified elsewhere.

3. SAMPLES

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

4. FABRICATION

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

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

5. PROTECTION OF MATERIALS

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

6. WOODEN DOORS

6.1 Materials

6.1.1 First class Deodar wood as approved by the Engineer shall be used for door frames and door shutters except the core of shutters which shall be partal wood as specified and shown on drawings.

6.1.2 Architraves, beads, lippings shall be of Deodar wood of specified sizes and fixed as per details shown on Drawings.

6.2 Ground, Blocking & Nailing Strips

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

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

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

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

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

6.3 Exterior and Interior Door Frames

All exterior and interior door frames shall be fabricated of wooden sections of first class deodar wood frame as shown on drawings.

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

The door frames shall be secured in place by means of 4 inches screws and matching Rawal plugs and built into the plastered masonry after the same has dried. 4 number screws in each jamb and 2 number for upto 3.5 feet width and 3 number for upto 5 feet width of doors in the head shall be used.

6.4 Door Shutters

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

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

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

6.4.3 All door shutters shall be paneled, fabricated from first class deodar wood as shown on drawings.

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

6.4.5 Completed doors shall be sound, rigid and free from defects and warp. All edges shall be aligned and smooth, joints shall be close fitting, hard wood doweled or mortised framed and of a strength to maintain frame and of strength to maintain the structural properties of the member connected. All adjoining

faces and edges shall be flush and smooth. Edges shall be rectangular and solid.

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

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

6.5 Fitting, Hanging and trimming

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

Doors shall have a clearance of 1/8" at sides and top unless otherwise directed by the Engineer and shall have 3/16" clearance at bottom. Doors shall be hung and trimmed with hardware as specified. All the locks shall be installed at the same height and shall be located at height as directed by the Engineer. Where directed by the Engineer margin for carpet shall be incorporated in the door shutter.

6.6 Hardware

Hardware shall be of best quality local make extra heavy duty and first class finished material except door locks and door closures which shall be imported of Japanese origin as per attached hardware schedule. The Contractor shall obtain prior approval from the Engineer for quality, shape, pattern, and brand of all the hardware materials by providing samples and catalogues, etc., and shall provide and fix only the approved hardware materials.

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

6.7 Quality Assurance

6.7.1 Tolerances: Doors shall be fabricated to following tolerances

- Size: Plus or minus 1/16 in overall dimensions
- Maximum Warp: 1/8"

- Squareness: Maximum diagonal difference 1/8" of (between length of diagonal measured on face of door from upper right corner to lower left corner and length of diagonal measured from upper left corner to lower right corner).

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

6.8 Submittal

6.8.1 Provide manufacturer's literature completely describing products.

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

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

6.8.4 Submit samples of plywood for selection of colour and grain.

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

6.9 Product Delivery, Storage and Handling

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

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

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

6.10 Installation

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

6.10.2 Install finish hardware in accordance with manufacturer directions.

7. Not used

8. WOODEN RAILING

Material for wooden hand railing in stairs shall be superior quality teak wood/ deodar wood & 1½ inch dia mild steel pipes. It shall be fabricated and installed in accordance with the design shown on the drawings/details and as per the instructions of the Engineer. Sample of railing shall be fabricated & mock up samples installed at locations designated by the Engineer for approval, prior to starting work at site. Shop/detail drawing indicating the basic details at various locations including details at turnings shall be submitted by the Contractor for Engineer's approval. Hand railing shall be installed to line level and plumb. The surface of railing in stairs shall be prepared for polishing. The railing shall be polished/painted with clear lacquer and the steel surfaces shall be painted with matt finished enamel paint.

9. SS & GLASS RAILING

Material for hand railing in stairs shall be 3” dia stainless steel pipe handrail, 1” dia stainless steel balustrades, ½” thick unbreakable security glass and clamps including all fixing accessories complete in all respect as shown on the drawings, It shall be fabricated and installed in accordance with the design shown on the drawings/details and as per the instructions of the Engineer. Sample of railing shall be fabricated & mock up samples installed at locations designated by the Engineer for approval, prior to starting work at site. Shop/detail drawing indicating the basic details at various locations including details at turnings shall be submitted by the Contractor for Engineer's approval. Hand railing shall be installed to line level and plumb.

10. DEFECTIVE WORK

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

11. SURFACE PREPARATION

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

12. MOCK-UP SAMPLE

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

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

13. MEASUREMENT & PAYMENT

13.1 General

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

13.1.1 Glazing where required and all finished hardware fittings in carpentry and joinery works, including locks, kick and push plate, architrave, beading, handles, locking arrangements etc.

13.1.2 Prime coat, painting with synthetic enamel paint/lacquer polish in carpentry and joinery works/hand railing.

13.1.3 Anti termite treatment to wood works and adhesives

13.1.4 SS / Steel balusters, steel base and steel strip for wooden railing.

13.1.5 Deodar wood blocking, shipping & base frame work in cabinets/hand railing.

13.1.6 SS Plate in the door bottom.

13.2 Wooden Door

13.2.1 Measurement

Measurement of acceptably completed works of all types of wooden doors will be made on the basis of net actual area in square foot fabricated and installed

in position as shown on the Drawings or as directed by the Engineer. Net area will be measured in accordance with plastered masonry opening in between jambs and plastered head and bottom of shutter.

13.2.2 Payment

Payment will be made for acceptable measured quantity of all types of wooden doors on the basis of unit rate per square foot quoted in the Bill of Quantities against respective item and shall constitute full compensation for all the works including all hardwares & fittings like locks, tower bolts, push plates etc. as per details mentioned in Volume IV of Tender & Contract Document related to the item.

13.3 Kitchen Cabinets

13.3.1 Measurement

Measurement of acceptably completed work of kitchen cabinets will be made on the basis of net actual running foot of kitchen cabinets provided and installed in position as shown on the Drawings or as directed by the Engineer.

13.3.2 Payment

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

13.4 Railing

13.4.1 Measurement

Measurement of acceptably completed work of railing comprising all accessories will be made on the basis of net actual running foot of railing provided and installed in position as shown on the Drawings or as directed by the Engineer.

13.4.2 Payment

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

*** End of Section 4600 ***

SECTION - 6250

GLAZING

SECTION - 6250

GLAZING

1.0 SCOPE

The work under this section of the Specifications consists of furnishing all labour, equipment, tools, appliances, scaffoldings and providing glass gaskets, sealants, compound and other materials required for performing all operations in connection with the installation and setting of all types of glass, glazing and glass blocks complete in every respect in accordance with the Drawings or as directed by the Engineer. The scope of this section of Specifications is covered with detailed Specifications as 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)

952 Glass for glazing

5051 Security glazing part I & II

CP.152 Glazing

3.0 GENERAL

3.1 Each type of glass shall have the manufacturer's label on each pane, and the labels shall remain on the glass until final cleaning.

3.2 Glazing sealant shall be as recommended by the manufacturer for the particular application.

3.3 Spacer shims (distance pieces) shall be plasticised polyvinyl chloride (PVC.) Thickness shall be equal to space shown on drawings between glass and rebates, bead or cleat. Depth shall give not less than 6 mm cover of glazing sealant.

3.4 Contractor shall submit samples for each type of glass, minimum 1200 mm x 1200 mm (4 ft. x 4 ft.) in size with protective edges. Samples of glazing sealant minimum 0.1 liter of specified types shall be submitted. Samples of minimum of three glass blocks shall also be submitted.

3.5 Contractor shall submit 300mm (12 in.) long sample of each type of glazing gasket.

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

4.0 DELIVERY, STORAGE AND HANDLING

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

4.2 Contractor shall store the materials in original unopened containers with labels intact/protected from ground contact and from elements, which may damage glass.

4.3 Contractor shall handle the materials in a manner to prevent breakage of glass and damage to surfaces.

5.0 MATERIALS

5.1 General

Glass shall be free from all blemishes, bubbles, distortions and other flaws of any kind and shall be properly cut to fit the rebates so as to have a uniform clearance of 1.6mm round the panes between the edges of glass and the rebates.

5.2 Sheet glass

It shall be first quality clear glass conforming to the applicable requirements of B.S 952 " Glass for Glazing". Unless otherwise indicated glass shall be 5mm thick glass for exterior window except where obscure glass is specified. Glass shall be free from specks, bubbles, deterioration and flows of every kind.

5.3 Frosted Glass

Frosted Glass shall be 5mm thick except as otherwise indicated. Glass shall be of approved pattern.

5.4 Glazing Sealants and Compounds

Contractor shall provide material colored to match frame in which glass is installed. Provide only compounds known to be fully compatible with surfaces which they will contact as follows.

5.5 Tinted Glass

Glass for windows ventilator & door shall be of 5mm(1/4”) thickness and of make approved by the Engineer.

6.0 INSTALLATION OF GLAZING

6.1 Glazing shall comply with the recommendations contained in the "MANUAL of GLAZING" of the Glass Marketing Association or as specifically recommended otherwise by the glass and glazing materials manufacturers.

6.2 Examine each piece of glass and discard and replace glass with edge damage or face imperfection. All glazing shall be wind tight and fully water tight on completion.

6.3 Clean glazing channels and other framing members indicated to receive glass. Remove coatings which are not firmly bonded to the substrate, Remove lacquer from metal surfaces wherever electrometric sealants are to be used. Apply primer and sealer to joint surfaces wherever recommended by the sealant manufacturer and as shown on the drawings.

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

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

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

6.7 No glazing shall be considered complete until and unless paint and other stains have been removed from the surface of the glass and checked by the Engineer for water tightness.

7.0 PROTECTION AND CLEANING OF GLAZING

7.1 Remove all smears, labels and excess glazing sealant, Leave clean inside and outside free from scratches. The Contractor shall be responsible for the protection of installed glass. Before final acceptance, damaged or broken glass shall be removed and replaced with new glass at no additional expense to the Employer.

7.2 All glass surfaces shall be washed clean both inside and outside within two weeks prior to final acceptance by the Employer.

8.0 MEASUREMENT AND PAYMENT

No payment shall be made for the works involved within the scope of this section of specifications unless otherwise specifically stated in the Bill of Quantities or herein. The cost thereof shall be deemed to be included in the quoted unit rates of the relevant item of the Bill of Quantities.

*** End of Section 6250 ***

SECTION - 6411

WATER PROOFING/EXPANSION JOINT FILLING & BUILT UP ROOFING

SECTION - 6411

WATER PROOFING/ EXPANSION JOINT FILLING & BUILT UP ROOFING

1.0 **SCOPE**

The work under this section of the Specifications consists of furnishing all plant, labour, equipment, appliances and materials and in performing all operations in any floor and at any height in connection with water-proofing and built-up roofing, including water proof treatment to foundations and basement structures 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 **SUBMITTAL**

2.1 Shop Drawings: Shop drawings shall be submitted showing layout and all the details for construction.

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

3.0 **MATERIALS**

3.1 Bitumen 10/20 grade shall be according to BSS.

3.2 Bitumen priming oil shall be of the approved manufacturer.

3.3 Flexible cementitious water proofing AQUAFIN-TC 07 & AQUAFIN -2K/M or approved equivalent

3.4 Polyethylene building film visqueen standard or approved equal. The film shall be 150 micron thick.

3.5 Cement and aggregates shall be in accordance with specifications for "Plain and reinforced concrete".

3.6 Geotextile with density 125 g/m^2.

3.7 Brick clay tiles shall conform to the specifications for “Brick Masonry”.

3.8 Puddled earth shall be composed of stiff clay to which an equal amount of chopped rice husk/bhoosa shall be added.

3.9 Polysulphide sealant of approved manufacturers

3.10 Aluminum Flashing

3.11 Water proofing agent shall be in accordance with specifications or as directed by the Engineer.

4.0 **DELIVERY STORAGE AND HANDLING**

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

5.0 **PREPARATORY WORK**

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

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

6.0 WATER PROOFING TREATMENT IN FOUNDATIONS AND SURFACES IN CONTACT WITH EARTH

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 or asphalt oil used at the rate of not less than 1 gallon /100 square feet. Two coats of hot bitumen paint shall be applied at the rate of 1 kg/Sq.m. each coat. The first coat shall be allowed to dry for about 6 hours before applying the second coat. During operation of painting great care shall be taken to avoid air bubbles. The manufacturers shall be taken to avoid air bubbles. The manufacturer's instructions and Engineer's directions shall be followed.

7.0 APPLICATION OF WATER PROOFING TO UNEDERGROUND WATER RETAINING STRUCTURES

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

7.2 Cementitious based water proofing shall be applied as per manufacturer’s recommendation and to the satisfaction of the Engineer.

8.0 EXPANSION JOINT FILLING

Before filling of Expansion Joint the surface shall be thoroughly cleaned and filling/packing material removed up to a depth of 50mm (2 in.). Backer Rod shall then be inserted throughout the length of joint and pressed in. The joint shall then be sealed with 2 part polyurethane sealant. The expansion joint shall be covered with 22 SWG GI Flashing sheet of shape and size shown on drawings.

9.0 MEASUREMENT AND PAYMENT

9.1 General

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

9.1.1 All preparatory work, scrapping, scratching, cleaning, cant strips, gravel strips, etc.

9.1.2 Formwork

9.1.3 Roof treatment including Class ‘C’ cement concrete

9.1.4 Coats of bitumen.

9.1.5 Polyethylene sheet including laps/overlaps and joints.

9.1.6 Class 'C' cement concrete cant strip.

9.2 **Bitumen Painting/Coating**

9.2.1 Measurement

Measurement of acceptably completed works of bitumen painting/coating will be made on the basis of net actual area in square meter / square foot as shown on the Drawings or as directed by the Engineer.

9.2.2 Payment

Payment will be made for acceptable measured quantity of bitumen painting/coating on the basis of unit rate per square meter / square foot quoted in the Bills of Quantities. The unit rate shall include all cost of surface preparation and shall constitute full compensation for all the works related to the item.

9.3 **Waterproofing and Built-Up Roofing**

9.3.1 Measurement

Measurement of acceptably completed works of Waterproofing and Built-Up Roofing will be made on the basis of net actual area in square meter / square foot as shown on the Drawings or as directed by the Engineer.

9.3.2 Payment

Payment will be made for acceptable measured quantity of Waterproofing and Built-Up Roofing on the basis of unit rate per square meter / square foot quoted in the respective items of Bills of Quantities. The unit rate shall include all cost of surface preparation and shall constitute full compensation for all the works related to the item.

9.4 **Expansion Joint**

9.4.1 Measurement

Measurement of acceptably completed works of expansion joint will be made on the basis of actual length of treated expansion joint in running meter / running foot as shown on the Drawings or as directed by the Engineer.

9.4.2 Payment

Payment will be made for acceptable measured quantity of expansion joint on the basis of unit rate per running meter / running foot quoted in the respective items of Bills of Quantities. The unit rate shall include all cost of surface preparation and shall constitute full compensation for all the works related to the item.

*** End of Section 6411 ***

SECTION - 6531

MARBLE WORKS

SECTION - 6531

MARBLE WORKS

1.0 SCOPE

The work under this section of specifications, consists of providing all material, labour, plant, equipment, appliances in any floor and at any height and performing all operations required for providing and installing marble natural stone slab for toilet counters, where shown on the drawings, complete in strict accordance with this section of the specification and the applicable Drawings.

2.0 SUBMITTALS

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

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

Submit three ranges samples 300mm x 300mm (12 in. x 12 in.) in size of each type of stone showing colour, grade, finishing and texture for approval of the Engineer.

3.0 DELIVERY, STORAGE AND HANDLING

Materials shall be protected from damage during loading, shipment, delivery and storage. Non-staining materials for blocking and packing shall be used. Stack marble at site in accordance with manufacturer's recommendations and as required to prevent staining, scratching, etching or breakage.

4. MATERIALS

4.1 General

Marble shall be compact, dense, metamorphic rock of lime stone origin obtained from quarries within Pakistan. It shall have a specific gravity of 2.7 and hardness number on Moh's scale shall range from 3 to 4.

Obtain each marble stone type from a single quarry and ensure consistent colour range and texture throughout the work. All pieces shall be of uniform thickness and truly square in shape.

Provide marble slabs/sills and tiles of specified sizes in floors, stair tread & risers and counter tops as shown on drawings.

Provide marble slabs/sills and tiles of type, colour and finish for each area as directed by the Engineer.

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

Provide irregular shaped units, staircase units and skirting base units to the profiles of required shapes & sizes and polished exposed surfaces wherever specified.

4.2 Marble Stone Type

All marble stone types are to be selected and approved by the Engineer for quality, colour and texture.

Marble: Marble of approved type and colour of local origin, first class quality and high class finish acceptable to the Engineer.

4.3 Beds and Backings

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

Grey ordinary Portland Cement	: 1 part
Sand	: 2 parts
Water	: Clean, fresh and free from deleterious substances

4.4 Adhesives, Grouts and Sealants

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

5.0 EXECUTION

5.1 Flooring, Skirting, Dado and Stair/Counter tops

Apply cement slurry coat over surfaces of concrete substrate immediately prior to placing setting bed which shall comprise cement sand mortar 1:2 and shall be 1" thick or as specified and shall be spread uniformly. Limit area of application to avoid premature drying out. Install setting bed of required thickness and set stone units before initial set occurs. Apply a thin layer of cement paste to bottom of each unit. Set tamps and level units immediately so that cement mortar slurry rises up in the joint. Set units in required pattern with uniform joint widths. The levels and lines shall be checked with very fine twine and the defects removed immediately. After the tiles/slabs have initially set, the joints shall be raked out and coloured cement of required shade shall be spread in the form of slurry to fill all joints.

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

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

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

5.2 Marble Toilet Counters

Marble toilet counter tops of the specified size shall be installed in areas shown on Drawings with M.S. angle framing and fixing accessories in accordance with approved shop drawing. Joints shall be cement grouted with matching colour or with matching colour sealant.

5.3 Repair and Cleaning

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

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

5.4 Protection

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

5.5 Polishing

The finished surface after drying shall be grinded and chemically polished, acceptable to the Engineer.

The finished surface shall not show any depressions in individual tiles or any undulation in the floor.

Do not permit traffic on finished surface during setting and for a minimum of 72 hours.

6. MEASUREMENT AND PAYMENT

6.1 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.

6.1.1 Finishing, washing, polishing, repair cleaning and protection of marble stone/tiles in position.

6.1.2 Proprietary adhesives, joint grouts and sealants for fixing marble stone where specified on the Drawings or directed by the Engineer.

6.1.3 Class 'C' cement concrete screed bed and 1:2 cement sand mortar for marble stone/tiles in floors, skirting, steps, etc.

6.1.4 Preparation of concrete substrate for laying marble sills/slabs and tiles.

6.1.5 M.S. angle framing and fixing accessories for marble counters.

6.1.6 Chemical polishing on marble surfaces.

6.2 Marble Flooring, Dado and Stair/Counter tops

6.2.1 Measurement

Measurement of acceptably completed works of marble Flooring, Dado and Stair/Counter tops will be made on the basis of net actual area in square meter / square foot of marble Flooring, Dado and Stair/Counter tops provided and installed in position as shown on the Drawings or as directed by the Engineer.

6.2.2 Payment

Payment will be made for acceptable measured quantity of marble Flooring, Dado and Stair/Counter tops on the basis of unit rate per square meter / square foot quoted in the respective items of Bills of Quantities and shall constitute full compensation for all the works related to the item.

6.3 Marble Skirting

6.3.1 Measurement

Measurement of acceptably completed works of marble skirting will be made on the basis of actual length in running meter / running foot of marble skirting provided and installed in position as shown on the Drawings or as directed by the Engineer.

6.3.2 Payment

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

6.4 Marble Vanity Top

6.4.1 Measurement

Measurement of acceptably completed works of marble vanity top including precast slab, masonry and other related civil works, will be made on the basis of net actual area in square meter / square foot of marble vanity top provided and installed in position as shown on the Drawings or as directed by the Engineer.

6.4.2 Payment

Payment will be made for acceptable measured quantity of marble vanity top including precast slab, masonry and other related civil works, on the basis of unit rate per square meter / square foot quoted against respective item in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

*** End of Section 6531 ***

SECTION - 6600

FLOOR AND WALL FINISHES

SECTION - 6600

FLOOR AND WALL FINISHES

1.0 SCOPE

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

2.0 MATERIALS

2.1 Cement

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

2.2 Sand

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

Percentage (by weight) passing

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

2.3 Coarse Aggregate

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

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

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

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

Any aggregates not found to be of the specified/approved standard shall be rejected by the Engineer and all such rejected material shall be removed from site with-out delay.

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

2.4 **Stone Ballast**

50 mm (2 in.) and down gauge graded Stone ballast shall be used under flooring.

2.5 **Water**

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

2.6 **Ceramic/Porcelain tiles**

Ceramic tiles shall be local, premium quality, plain, white/colored or printed from one of the approved manufacturer. The ceramic tile shall be acid resistant, glazed or non skid tiles as shown on drawings. Porcelain tiles shall be imported best quality plain colored / textured from one of the approved manufacturers. The tiles shall be of sizes as specified on the drawings and shall conform to BS 1281 as per samples.

2.7 **Cleaning Compound**

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

2.8 **Terrazzo Tiles**

Terrazzo tiles shall be first grade mechanically compressed type conforming to PS-531. Tiles shall be 30x30xcm (12 in. x 12 in.) with a topping of 19mm (3/4 in.) thickness composed of 1:2 cement marble chips the bases being 1:2 cement mortar. The colour, quality and size of chips shall be as per Engineer’s direction.

2.9 **Ironite Floor Hardener Topping**

Ironite Floor Hardener Topping shall be a graded, processed, non-oxidizing, non-rusting, inert metallic aggregate compatible with ordinary Portland cement designed for use in industrial pavings and floors to produce heavy duty, dense and tough floor surfaces able to wear, abrasion and dusting.

2.10 **Concrete Split Block**

Concrete split block shall be of Primecrete or Envicrete make or approved equivalent.

3.0 **CEMENT CONCRETE FLOORING**

The materials for C.C flooring shall be same as already specified under clause 3, "Materials".

3.1 **Composition of Concrete**

Concrete shall be composed of Portland Cement, sand, coarse, aggregate and water, all well mixed and brought to the proper consistency. The Contractor shall mix the ingredients as indicated on the Drawings. The proportions of the various ingredients shall be determined from time to time during the progress of the work and tests shall be made of

samples of the aggregates and the resulting concrete. The mix proportions and appropriate water-cement ratio will be determined on the basis of the production of concrete having required workability, density, impermeability, durability and required strength.

3.2 Mixing Concrete

The concrete ingredients shall be mixed in a batch mixer for not less than 1-1/2 minutes after all ingredients, except the full amount of water, are in the mixer. The Engineer reserves the right to increase the mixing time when the charging and mixing operations fail to produce a concrete batch in which the ingredients are uniformly distributed and the consistency is not uniform. The concrete shall be uniform in composition and consistency from batch to batch except when changes in composition or consistency are required. Water shall be added prior to, during and following the mixer charge. Excessive over-mixing requiring addition of water to preserve the required concrete consistency will not be permitted. The concrete ingredients shall be mixed by volumetric measurement in purpose made boxes approved by the Engineer.

3.3 Construction

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

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

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

The expansion joints shall be filled in with hot bitumen, of the approved grade, as directed by the engineer.

4.0 INSTALLATION OF TILE FLOORING

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

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

4.1 General

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

The curing period of the setting bed shall be as directed by the Engineer. As large an area of setting bed shall be spread at one time as can be covered with tiles before the mortar has set. Surplus mortar shall be removed. The thickness of setting bed in any space shall not be less than 13mm (1/2").

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

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

4.2 Ceramic/Porcelain Tiles

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

4.3 Terrazzo Tiles Flooring

The tiles shall be well soaked in water and kept in a vertical position to drain out all surplus water. The bed over which the tiles would be laid shall be 25mm thick cement sand mortar as specified by the Engineer. The cement sand mortar shall be prepared and mixed with clean granular sand in the proportion of 1:2 and spread uniformly on the thoroughly wetted and moist surface. The tiles shall be laid on this cement mortar slurry rises up in the joint. The tiles shall be laid in the pattern as specified by the Engineer. The levels and lines shall be checked with very fine twine and the defects removed then and there. After 3 or 4 days the slurry from the joints shall be raked out and colored cement of required shade shall be spread in the form of slurry to fill all joints. It shall be neatly wiped out of the surface when still wet. After about 10 days the area shall be rubbed and ground with Carborundum stone and the whole surface rendered smooth and washed with plenty of water. After allowing to dry the surface shall be wax polished. The finished surface shall not show any depressions in individual tiles or undulations in the floor.

5.0 IRONITE FLOOR TOPPING

5.1 Base Preparation

Ironite (floor hardener) flooring is directly laid over fresh green concrete. The base concrete shall be placed in accordance with good concrete practice and extra care should be exercised at corners and edges to obtain good compaction. Any free water from the surface of the base slab shall be removed prior to the application of ironite topping.

5.2 Mixing & Application

The floor hardener shall be mixed well with cement in a ratio as specified by the manufacturer. The water cement ratio of ironite topping shall be kept as low as per site conditions. Ironite topping shall be laid within three hours of laying of the base slab. Surface shall be toweled till all pores and pinholes thus formed have disappeared. Final toweling shall be delayed for as long as possible.

5.3 Curing

Ironite flooring shall be cured for at least 14 days with a spray of clean water or a suitable curing compound. During the curing period the surface should be protected from traffic and other potential hazards.

6. MEASUREMENT AND PAYMENT

6.1 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.

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

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

6.1.3 Class 'C' cement concrete screed base and 1:4 cement sand mortar under floor.

6.1.4 Rough plaster base under skirting / dado.

6.1.5 Finishing/grinding, washing & polishing works of ceramic, concrete, terrazzo tile, terrazzo floors and marble tiles.

6.1.6 Marble strips in terrazzo floors

6.1.7 1:2 and 1:4 cement sand rough cast plaster.

6.1.8 Sand cushion under concrete pavers

6.1.9 Pigmented grouting.

6.1.10 Cleaning of tiles after installation.

6.1.11 Bull-nozing, chamfering of edges of marble tops including base mortar and making holes for wash basin including all necessary fixing accessories.

6.1.12 Liquid water proofing, if required.

6.2 Cement Concrete Floor

6.2.1 Measurement

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

6.2.2 Payment

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

6.3 Ceramic/Porcelain Tile Floor

6.3.1 Measurement

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

6.3.2 Payment

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

6.4 **Ceramic/Porcelain Tile Dado/Skirting/Cladding**

6.4.1 Measurement

Measurement of acceptably completed works of ceramic/Porcelain tile in dado/skirting/cladding will be made on the basis of net actual area in square meter / square foot of dado/skirting laid in position as shown on the Drawing or as directed by the Engineer.

6.4.2 Payment

Payment will be made for acceptable measured quantity of ceramic/porcelain tile in dado/skirting/cladding on the basis of unit rate per square meter / square foot quoted in the respective items of Bills of Quantities. The unit rate shall include all cost of cement, sand, mortar and shall constitute full compensation for all the works related to the items.

6.5 **Terrazzo Tile Floor/skirting/dado**

6.5.1 Measurement

Measurement of acceptably completed works of terrazzo tile in floor/skirting/dado will be made on the basis of net actual area in square meter / square foot of floor laid in position as shown on the Drawing or as directed by the Engineer.

6.5.2 Payment

Payment will be made for acceptable measured quantity of terrazzo tile in floor/skirting/dado 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.

6.6 **Ironite Floor Topping**

6.6.1 Measurement

Measurement of acceptably completed works of ironite floor topping will be made on the basis of net actual area in square meter / square foot laid in position as shown on the Drawings or as directed by the Engineer.

6.6.2 Payment

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

6.7 **Concrete Split Block Cladding**

6.7.1 Measurement

Measurement of acceptably completed works of pigmented concrete split block cladding will be made on the basis of net actual area in square meter / square foot laid in position as shown on the Drawings or as directed by the Engineer.

6.7.2 Payment

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

6.8 **Concrete Skirting**

6.8.1 Measurement

Measurement of acceptably completed works of concrete in skirting will be made on the basis of net actual area in square meter / square foot of dado/skirting laid in position as shown on the Drawing or as directed by the Engineer.

6.8.2 Payment

Payment will be made for acceptable measured quantity of concrete in skirting on the basis of unit rate per square meter / square foot quoted in the respective items of Bills of Quantities. The unit rate shall include all cost of cement, sand, mortar and shall constitute full compensation for all the works related to the items.

*** End of Section 6600 ***

SECTION - 6700

PAINTING

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 ***

ELECTRICAL WORKS

SECTION - 8001

GENERAL SPECIFICATIONS FOR ELECTRICAL WORKS

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 ± 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/marking. 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 After one hour's run:	Oil Pressure 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 ***

SECTION - 8133

LT DISTRIBUTION BOARDS

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 co-ordinate 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 gasketting 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^{o}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 diagramatically 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.

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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 (±5%) in 36W replacement for 2x36W waterproof TL-D Batten
2700 lumens (±5%) in 28W replacement for 2x36W fluorescent TL-D Batten
1350 lumens (±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 Ta = 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 (±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 140º.

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 Ta = 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 gasketted 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 ºC and shall be capable to operate efficiently within the temperature limit of -40 ºC to 50 ºC. 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 ºC and shall be capable to operate efficiently within the temperature limit of -40 ºC to 55 ºC. 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 - 8212

LOW TENSION CABLES

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 low tension (LT) cables and the accessories as specified herein or as 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 route, location and position of the L.T. cables.

The LT cables 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

All multi-core and single core PVC insulated and sheathed cables LSZH for light circuits, socket outlets and circuits operating upto 250 volts shall be 300/500 volts grade. All single core PVC insulated, non-sheathed cables shall be of 450/750-volt grade. Power cables for main feeders, main to sub main feeders, power equipment, etc., armoured or unarmoured shall be of 600/1000 volt grad/XLPE. Armouring of multi-core/ single core cables shall be done with appropriate size galvanized steel/aluminium wire as per relevant codes.

The conductors shall be stranded high conductivity, soft annealed copper. Conductors of single core cables shall be circular, whereas of multi-core cables may be circular or shaped according to standard practices and codes. The PVC insulation, bedding and overall sheath shall be of extruded PVC compound having good flexibility, resistance to ageing and ability to withstand deformation at high temperatures. Non-hygroscopic filler shall be provided in multicore cable to fill empty gaps between the cores to make the cable a smooth round finish. In all shaped cables a non-hygroscopic high strength binding tape shall be provided on the core assembly. All cables shall be treated for vermin proofing and be protected against rodents during storage, laying and all protective pipe/sleeves shall be plugged to attain the same after installation.

Embossed marking on the oversheath at 3 meters intervals shall give the following information :

- name of Manufacturer
- year of Manufacture
- No. of cores and size of cable in sq.mm.
- voltage grade
- type of cable i.e. Cu./PVC/SWA/PVC

3.0 APPLICABLE STANDARDS/CODES

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

BS 6004	-	Electric cables PVC insulated, non armoured cables for voltages upto and including 450/750 volts for electric power, lighting and internal wiring
BS 6346	-	Electric cables PVC insulated, armoured cables for voltages of 600/1000 V and 1900/3300 V
BS 6746	-	PVC insulation for electrical cables
BS 6360	-	Copper conductors
BS 6500	-	Insulated flexible cords
BS 7846	-	Electric cables 600/1000 V armoured fire resistant cables having thermosetting insulation and low emission of smoke and corrosive gases when affected by fire
BS 7889	-	Electric cables. Thermosetting insulated, unarmoured cables for a voltage of 600/1000 V
BS EN 50266	-	Common test methods for cables under fire conditions

4.0 MATERIAL

4.1 General

The power, lighting and control cables shall be furnished and installed in accordance with the routes and requirements shown on the drawings.

All cables shall have phase identification colours on insulation of each core. The colour code for three phase circuits shall be red, yellow and blue for phase conductors and black for neutral conductor. Where insulated earth conductor is installed, it shall have green or green-yellow colour insulation.

Single-phase circuits shall have insulation of red colour for phase/line, black colour for neutral and green or green-yellow colour for earth conductor.All DC circuits shall have insulation of white colour for positive, black colour for negative and green or green-yellow colour for earth conductor.

The ends of each length of multi-core armoured or unarmoured cables shall be properly marked for clock-wise and anti clock-wise sequence of core colours.

4.2 Cables for Conduit or Channel Wiring

All cables/wiring in concealed or surface mounted PVC conduits or in covered channel shall be single core PVC insulated LSZH of specified grade and size, unless specifically shown on the drawings or given in BOQ.

The contractor shall wire all power receptacles/points from the panels using copper stranded conductor having proper insulation and PVC sheathing. Under no circumstances shall wire pulling compound be used when pulling the wire for isolated circuits. All wiring shall be color-coded in accordance with applicable standards.

4.3 Cables on surface/concrete trenches/cable trays

Cables for distribution system to be installed on surface, in cable ducts, in concrete trenches or on trays shall be single or multi-core PVC insulated and PVC sheathed of specified voltage grade and size, unless specifically shown on the drawings or given in BOQ.

4.4 Cable Accessories

All cable accessories shall be provided for the complete cabling and wiring system without any additional cost unless specifically mentioned in BOQ. These shall include but not limited to the items such as saddles, clamps, fixing channels, connectors, cable joints (where necessary and as approved by the Engineer), clips, lugs, colour sleeves, identification tags, bushes, glands, etc.

5.0 INSTALLATION

5.1 General

All installation material, labour, tools, cable rollers and accessories for cable installation shall be furnished by the Contractor. The cable and accessories shall be installed as described in accordance with these Specifications, drawings and manufacturer's instructions.

The Contractor shall confirm the exact cut lengths for cable by actual measurements at site prior to the ordering. The cable lengths where shown on the drawings or in BOQ are tentative and only for general guidance. The Contractor shall be solely responsible for furnishing

correct lengths of cable to avoid joints in cable length except where necessary, after obtaining approval of the Engineer.

No separate payment for such joints is admissible.

Necessary precautions for safety of cables shall be taken during the laying of cables to avoid scratches/ cuts to the cable surface. Pulling force on cable at all times shall remain well within the manufacturer's recommended limits.

Prior to installation of jointing and termination kits, the cable lengths shall be checked and tested to ensure that the cables are in sound condition, and no damage has been done during handling and installation. After installation, these shall again be tested prior to commissioning as per recommendations of the standards according to which the cable is manufactured.

5.2 Conduit or Channel Wiring

The wiring through conduit shall be started only after the conduit and channel system is completely installed and all outlet boxes, junction boxes, etc., are fixed in position.
The wires shall be pulled in conduit or channel with care, preferably without the use of any lubricant. Where necessary and if approved by the Engineer, the cable manufacturer's recommended lubricant may be used. Where several wires are to be installed in the same conduit, they shall be pulled together along with the earth conductor. All wires of same circuit shall be run in one conduit.

The wires shall not be bent to a radius less than ten times the overall diameter of the wire, if otherwise recommended by the manufacturer.

The wiring shall be continuous between terminations and looping-in system shall be followed throughout. Any joint in wires shall not be allowed. The use of connectors shall only be allowed at locations where looping-in is rendered difficult. The consent of the Engineer shall be required for using connectors. The connector shall be of suitable rating having porcelain body with sunk-in screw terminals. The connector shall be wrapped with PVC insulation tape after its installation. A minimum of 150 mm extra length of cable/wire shall be provided at each termination to facilitate repairs in future.

5.3 Cables on Surface/Trenches/Cable Trays

All cables for installation on surface of wall, column, ceiling, trenches, etc., shall be fixed to the surface by means of galvanized steel clips secured to a steel channel using suitable stud plate, nuts and washers. The distance between each cable clip shall be such so as to support the

entire weight of the cable and that distance between the cable & surface and also the vertical clearance between two adjacent cables at any point is 50mm minimum. Common mounting channels are to be furnished for cable along the same route. The Contractor can offer alternate cable fixing arrangement, which shall be approved by the Engineer before commencement of installation.

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 as shown on the Bidding Drawing related to the item.

6.2 Light Circuit Wiring

6.2.1 Measurement

Measurement shall be made for the total number of light circuit wiring from LT distribution board to point/switch/push button including wiring between switches/push buttons on the same circuit, acceptably carried out by the Contractor as a complete unit.

6.2.2 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, connecting, testing, commissioning and completion of the circuit wiring from the LT distribution board to point/switch/push button including wiring between switches/push buttons on the same circuit complete with specified type of surface mounted/concealed conduit, (PVC or steel) required No. specified size single core PVC insulated cable, earth continuity conductor, accessories, etc.

6.3 Wiring of Light/Fan Point (Point to Switch/ Impulse Relay, Point to Point, or Group Controlled Light Points)

6.3.1 Measurement

Measurement shall be made for the total no. of wiring of light/fan points (point to switch, point to point, or group controlled light point), acceptably carried out by the Contractor as a complete unit.

6.3.2 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, connecting, testing, commissioning and completion of the wiring between light point to switch/ impulse relay, point to point or group controlled points including required no. of specified size single core PVC insulated cable, specified type of surface mounted/concealed conduit (PVC or Steel), earth continuity conductor, flexible cable, ceiling rose, one way or two way 10A light control switch, sheet steel box and other accessories, etc.

6.4 Wiring of Power Circuits (Distributor to socket outlets & between sockets)

6.4.1 Measurement

Measurement shall be made for the total number of each type of wiring acceptably carried out 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, connecting, testing, commissioning and completion of wiring of socket outlets etc. from distributor to sockets or between sockets with specified size and number of single core PVC cables LSZH cables including specified type of surface mounted / concealed conduit (PVC or Steel), ECC and all other accessories etc.

6.5 LT Cables

6.5.1 Measurement:

Measurement shall be made for the total running meter for each size and type of LT cable acceptably supplied and installed by the Contractor.

6.5.2 Payment:

Payment shall be made for the total running meter of each size and type of LT cable measured, as provided above, at the Contract unit price each and shall constitute full compensation for supplying, installing, connecting, testing and commissioning of the LT cables including all accessories such as cable joints, lugs,

colour sleeves, glands, bush, etc. complete with plugging of protective pipe/ sleeve ends for water tightening.

*** End of Section 8212 ***

SECTION - 8220

WIRING ACCESSORIES

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, and commissioning of all material and services of the complete Wiring Accessories including switches, switch sockets, etc., 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 all wiring accessories.

The wiring accessories such as switches, switch socket outlets, socket outlets and ceiling roses, etc. 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 locations of the wiring accessories such as switches, sockets, etc. are tentatively shown on the drawings. The Contractor shall ensure the exact positions and locations of wiring accessories in coordination with other services drawings, as per site requirements and as directed by the Engineer. The Contractor shall be responsible for proper functioning of wiring accessories after installation and commissioning.

The description of switches, switch sockets, socket outlets etc. are given in the Bill of Quantities, stated as drawings and in this section. The Contractor shall submit sample of each and every item of wiring accessories for the approval of the Engineer.

3.0 APPLICABLE STANDARDS/CODES

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

BS 3676	-	Switches for domestic and similar purposes.
BS 4343	-	Industrial plugs, socket outlets and couplers for AC and DC supplies.
BS 2135	-	Capacitors for radio interference suppression.
BS 67	-	Ceiling roses.
BS 546	-	2-pole and earthing pin plugs, socket outlets and socket outlet adaptors.
BS 1362	-	Specification for general purpose fuse links for domestic and similar purposes.

BS 1363 (Part 4-1995)	-	Specification for 13A fused connection units: switched and unswitched.
BS 5733 (1995)	-	Specification for general requirements for electrical accessories.
DIN EN 60669-1	-	Switches for household and similar fixed electrical installations.

4.0 MATERIAL

4.1 Switches/Blank Face Plates

Switches for controlling light and fan points shall be single pole, rated for 10 Amps, 250 volts AC. The body of the switches shall be of thermoplastic with faceplate suitable for flush mounting and colour as approved by the Engineer. The switches shall be gang type having silver tipped contacts and shall operate with snap action.

Unless otherwise specified wherever switches control only the light points, these shall be plate type gang switches installed on common outlet boxes. Where only sheet steel back box is indicated on drawings, blank face plates shall be provided of same make and model as that of switches.

Where specified weather proof or metal front plates shall be used with single grid type switches. The plate shall be finished in specified colour or as otherwise directed by the Engineer.

The bell push switches shall be spring loaded type with the identification symbol embossed on it.

Two-way and intermediate switches shall be used to control lights from two or more different locations particularly in staircase as shown on the drawings.

4.2 13A Switch-Socket/Socket Outlets

Switch socket/Socket units shall be 3 pin, 13 A 250V, AC with faceplate of colour as approved by Engineer. The outlets shall be heavy-duty type suitable for mounting on sheet steel outlet box. The 13 Amps Switch socket/Socket outlets shall have sheltered live contacts and designed such that the earth pin of plug is engaged to socket earth before making of live contacts.

Where metal plate switches are installed, the switch socket units shall also be provided with front plate of similar design.

4.3 15A Socket Outlets

15 Amps Socket Outlets shall be 2 pin + earth, 250V AC socket outlets with faceplate of colour as approved by the Engineerd by the Engineer.

The outlets shall be heavy-duty type suitable for mounting on sheet steel outlet box. The 15 Amps Socket Outlets shall be designed such that the earth pin of plug is engaged to socket earth prior to making contact to the live contacts.

4.4 32A Industrial Socket Outlet

The 32A, industrial socket outlet shall be weather proof conforming to the standard and requirements of relevant IEC codes.

The socket outlets shall be of heavy-duty type suitable for outdoor installation. The socket outlet shall be mounted on polycarbonate enclosure and have gasketed cover and window, captive cover screw type. All socket outlets shall be supplied with matching plugs.

4.5 64A Industrial Socket Outlet

The 16A, industrial socket outlet shall be weather proof conforming to the standard and requirements of relevant IEC codes.

The socket outlets shall be of heavy-duty type suitable for outdoor installation. The socket outlet shall be mounted on polycarbonate enclosure and have gasketed cover and window, captive cover screw type. All socket outlets shall be supplied with matching plugs.

4.6 Connection Unit

Connection Unit shall be used to supply to appliances where so specified or shown on drawings. (Air conditioner/Hand drier / Water heaters etc.).

It shall be rated for 20A, 250V AC or as shown on drawings/BOQ. The body shall be of thermoplastic material. Installation shall be surface/ concealed as required.

Face plate and colour to be as per approval of Engineer.

Connectors shall be of best quality (for Phase, Neutral and Earth) and suitable for the size of wiring.

The connection unit shall have the following features as per requirement in B.O.Q or as shown on drawing.

- 20 A Double Pole Switch
- Fuse – Rating as per requirement of appliance
- Neon Indication light
- Grommetted outlet on face plate suitable for flexible wiring connection to appliance

4.7 **Ground Jack Module**

Ground jack modules are used to make convenient ground connections for medical equipment of operation theaters. These unit contain ground jack receptacles and a ground bus. These modules shall be furnished with type #304 brushed stainless trim. These modules shall be provided with 30A twist-to-lock ground jacks, 1 No. copper ground bus bar 1/8" thick x ¾" wide and lug suitable for 2.5 sq. mm. earth cable connection.

4.8 **Fan Dimmers**

The fan regulator/dimmer shall be made of low voltage electronic components with essential radio frequency compressor and shall be designed for smooth speed control/variation of fans. The regulators/dimmer and fan control switches shall be of same make and colour as that of the approved wiring accessories. The regulator/dimmer and fan-controlling switch shall preferably be mounted on same face plate. They shall be suitable for flush mounting on a sheet steel outlet back box.

4.9 **Sheet Steel Back Boxes**

The sheet steel boxes for installation of switches, fan dimmers, socket, outlets and blank face plates shall be made of 16 SWG sheet steel having appropriate dimensions. The box shall have suitable arrangement for receiving the conduit(s). An earth terminal shall be provided for connecting at least three earth wires of 4-sq.mm size. The outlet box shall be finished in powder-coated paint. The sheet steel back box shall be as approved by the Engineer.

4.10 **Ceiling Roses**

The ceiling roses shall be suitable for 5 amps 250 volts single-phase ac. It shall have white plastic moulded base plate and copper or brass terminals suitable for connecting at least two wires of 2.5 sq. mm size. The ceiling rose shall have a cover with cable inlet hole suitable for multicore PVC insulated and PVC sheathed cable.

5.0 INSTALLATION

5.1 General

The mounting heights of all wiring accessories are stated on the drawings. In case the mounting height is not mentioned, the instructions of the Engineer shall be obtained before fixing.

5.2 Wiring Accessories Installation

All wiring accessories such as Switches, Blank Face Plates, 13/15A Switch Socket, 32/64/125A Industrial Socket Outlet, Connection Units & ground jack modules shall be installed on 1.63 mm (16 SWG) thick sheet steel box recessed in wall/column/floor. The faceplate shall be fixed on sheet steel box by means of flat head galvanized or brass screws sunk in the faceplate so as to finish flush with the surface. Matching screw caps shall be installed on the opening for screw in faceplates.

The units installed in integrated bed head units shall be fitted with the parallel power tracks provided with the unit.

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 as shown on the Bidding Drawing related to the item.

6.2 13A Switch Socket/Socket Outlets, 15 Amps Switch Socket/Socket Outlets, 32/64/125A Industrial Socket Outlet Connection Units & Ground Jack Module

6.2.1 Measurement:

Measurement shall be made for the total number of each type of socket outlet complete with sheet steel back boxes, polycarbonate enclosure and all accessories acceptably supplied and installed by the Contractor as a complete unit.

6.2.2 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, connecting,

testing and completion of each type and rating of outlet including screws, screw caps, sheet steel box, polycarbonate enclosure, nuts, bolts and other accessories as required.

*** End of Section 8220***

SECTION - 8230

CONDUITS AND PIPES

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 and commissioning of all material and services of the complete Conduits and Pipes as specified herein and/or shown on Tender Drawings and stated in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and co-ordinate at Site with other services for exact route, location and position of the conduits and pipes.

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

2.0 GENERAL

The extent of works shown on the drawing does not indicate the exact position of conduits and pipes. The Contractor shall ensure exact location and route of conduit and pipes in coordination with other services drawings, as per site requirements and as directed by the Engineer.

The conduit system shall be continuous with manufacturer's recommended accessories.

The quality and material for the accessories of conduits and pipes such as sockets, end cap, elbows, bushings, bends, inspection/pull boxes, round boxes, etc., necessary for the complete installation shall be similar to that of conduits or pipes. All the accessories shall be supplied by the Contractor without any extra cost and deemed to have been included in the price of conduits/pipes.

Pull wire shall be laid in all empty conduits.

3.0 APPLICABLE STANDARD/CODES

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

BS 4607	-	Non-metallic conduits and fittings for electrical installations.
BS 1387	-	Galvanized Iron (GI) pipes and fittings.
BS 3505	-	uPVC pressure pipe and fittings.

4.0 MATERIAL

4.1 PVC Conduit and Accessories

The PVC conduits and accessories for lighting and power circuits shall be furnished by the Contractor as shown on the drawings or given in BOQ. The PVC bends shall have enlarged ends to receive conduit without any reduction in the internal diameter at joint. Manufactured smooth bends shall be used where conduit changes direction. Bending of conduits by heating or otherwise will be allowed in special situations only for which the consent of the Engineer shall be required. The use of sharp 90 degree bends and tees will not be allowed for concealed wiring.

The round PVC junction boxes for ceiling light or fan points shall have minimum dimensions of 63 mm diameter and depth. The junction boxes for wall light points shall have minimum dimensions of 63 mm diameter and 38 mm deep. Round junction boxes shall be provided with one piece PVC cover plate fixed to the box by means of brass screws.

4.2 Inspection/Pull and Adaptable Boxes

Inspection/Pull boxes and adaptable boxes shall be provided in conduit runs wherever required to facilitate pulling operation. The drawings are diagrammatic and do not indicate the position and spacing of inspection/pull boxes or adaptable boxes. However, these shall be as per Engineer's approval.

4.3 uPVC Pipes and fittings

Unplasticised PVC pressure pipes and fittings shall conform to BS 3505:1968 and shall be of class-D (working pressure - 12 bars). The buried uPVC pipes should be able to withstand the external load acting upon it by continuous movements of heavy duty vehicles such as trucks, cranes, forklift etc. where pipe changes direction, manufacturer smooth bend shall be used.

Fittings and accessories for use with uPVC pressure pipes shall be of the same class and manufacture as the pipe and shall have the required shapes and dimensions of turned ends to fit the uPVC pressure pipes. uPVC pipes and accessories shall be suitable for jointing with rubber rings or solvent.

Bending of pipes by heating or otherwise will not be allowed. The use of sharp 90 degree bends and tees will not be allowed. The bends shall conform to same specifications as given for PVC conduits. For joining of pipe all precautions and procedures recommended by manufacturer shall be allowed.

Hard PVC or reinforced concrete pipe range spacers shall be used if there is more than one pipe running in parallel. The distance between range spacers shall be maximum 2 meters. Range spacers shall be prefabricated/precast and decay resistant.

Flexible pipes shall be used as deemed essential or as approved by the Engineer.

5.0 INSTALLATION

5.1 PVC Conduits and Accessories

5.1.1 Concealed Conduit

Where concealed conduit system is shown on drawings/ mentioned in BOQ, the conduit shall be installed concealed in roof, wall, column, etc. Conduits shall be laid under floor only where specifically stated. The entire conduit system shall be installed and checked before wring is carried out. Any obstruction found shall be cleared before the installation of cable.

When concealed, the conduit shall have a minimum of 32mm cover of concrete measured from the top of conduit to finished surface. In the reinforced cement concrete (RCC) work the conduit shall be laid before pouring of concrete. Under no circumstances shall chases be made in the RCC structure for concealing conduit and accessories after pouring of concrete. The conduit shall be supported on top of bottom reinforcement of slab. All outlet boxes to be firmly supported and installed such that they finish flush with the soffit of slab or beam.

Where conduits have to be concealed in cement concrete (CC) work after concreting or in block masonry, chase shall be made with appropriate tools and shall not be made deeper than required. The conduit shall then be fixed firmly in the recess and covered with cement concrete mixture. The work of cutting in the cement concrete work or block masonry work shall be coordinated with the civil work. The Contractor shall obtain approval from the Engineer before starting chasing and cutting.

The termination of conduits at or near the equipment / switchboard is shown diagrammatically on the drawings. The exact locations of the termination shall be coordinated with the equipment/switchboard to be installed. Any extension of conduit to suit the site condition shall be made without any extra cost. Conduit ends pointing upwards or downwards shall be properly plugged in order to present the entry of foreign materials. All openings through which concrete may leak shall be carefully plugged in order to prevent the entry of foreign materials. All opening through which concrete may leak shall be carefully plugged and boxes shall be suitably protected against filling with concrete. At all terminations of conduit, sharp edges of conduit ends shall be prevented to avoid the cutting or damaging of wires or cables during pulling through the conduits.

Under floor conduit shall be installed at a minimum depth of 2 inch from the finished floor level or as shown on the drawings. The conduits shall be installed empty, before finishing of floor or in RCC work, with an 18 SWG steel wire drawn through the conduit for pulling cable. No conduits shall be laid under floor in bathroom.

5.1.2 **Surface Conduits**

The surface conduits shall be installed where shown on drawings mentioned in BOQ. The conduits shall be installed parallel or perpendicular to the surface of wall, structural members, ceiling, etc., by means of PVC saddles and clamps of approved design. The conduits shall be kept at least 150 mm away from parallel runs of flues, steam pipes and hot water pipes.

The saddles shall be installed on surface by means of nylon or wooden plugs and galvanized screws. Appropriate size of holes in structure shall made by drilling, the thickness of saddles and clamps shall be at appropriate thickness and prime quality. The surface conduits shall be supported at maximum of one meter spacing along horizontal and vertical runs. The Contractor shall provide all accessories for complete installing of conduit system. The pull boxes, etc. as stated for concealed conduits shall also be applicable for surface conduit system.

5.2 **uPVC Pipe and Fittings**

uPVC pipes shall be installed as shown in the drawings. The depth of the pipe shall vary according to the conditions at site, and approval of Engineer shall be obtained prior to installation. In general the pipes shall be installed underground at the following depths measured from the top of the pipe.

- Under roads/pavement : 900 mm below finished surface.

- When crossing other services : 250/500 mm vertical/horizontal.

The trench of required dimensions shall be excavated and the bottom of trench cleaned and leveled. A 100 mm bed of fine sand shall be provided over which the PVC pipes installed after proper alignment. Where two or more pipes are installed in the same trench the clearance between pipes shall not less than 50 mm. This shall be done by the provision of pipe range spacers as per Engineers approval. After laying of pipe the trench shall be backfilled with clean screened sand at least 100 mm above the top most pipes. The remaining portion of trench shall be backfilled with selected earth in layers well compacted.

After installation, the ends of the pipe shall be plugged with manufactured end cap impervious to water and chemicals. All joints shall be sealed adequately not only to prevent entry of foreign elements bu water tightness shall be ensured.

The installation of pipes shall be completed in all respects including its fixing at terminations, before cabling work is started. All sharp edges and burrs shall be removed by using reamer or any approved device. The pipe shall

be through cleaned of dirt and dust from inside, the pipes shall be installed in proper co-ordination with other works.

The protective PVC pipe for cable entering building shall be installed so as to lead cable into the cable trench. The required number of pipes shall be fixed before completing the work in the plinth. If an opening is provided to the cable trench from outside, the required number of pipes shall be installed and part of the opening remained unutilized shall be properly packed and sealed using suitable packing material impervious to water and chemical to make it completely water-tight.
Spare pipes shall be provided with 5 mm dia rope pulled from end to end and plugged with manufactured end cap.

Flexible pipes of compatible material and size shall be used wherever deemed essential.

6.0 MEASUREMENT AND PAYMENT

6.1 General

The Contractors 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 Drawings related to the item.

6.2 Conduits PVC / Pipes PVC and Accessories

6.2.1 **Measurement:** Measurement shall be made for the total running feet of each type and size of conduits / pipes and accessories acceptably supplied and installed by the Contractor according to specification and as shown on drawings.

6.2.2 **Payment:** Payment shall be made for the total running feet of each type and size of conduits or pipes measured as provided above at the contract unit price each and shall constitute full compensation for supplying, installing and completion of the laying of the conduits and pipes including all accessories related to the item.

No separate payments shall be made for the under mentioned specified work related to the supply and installation of conduit and pipe. The cost thereof shall be deemed to have been included in the quoted rates of above work.

- Excavation and backfilling.
- Dewatering during excavation and backfilling.
- Providing and filling of fine sand in trenches.
- Providing pipe range spacers.
- Providing flexible pipes and accessories, jointing material/ compound, saddles, sockets, elbows, bend, junction boxes reducers, 16SWG GI pull wire for empty conduit,

and 5 mm rope for empty pipe, soft metal bush, making threads and plugging of pipe with manufactured end cap etc. whether used or left spare.

- Compacted backfilling of trenches with specified material and disposal of surplus and rejected material.

- Watertight sealing of any unutilized opening to the buildings after installing the protective pipes entering the buildings.

*** End of Section 8230***

SECTION - 8240

EARTHING

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

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 champhered.

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

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 posses 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 ^{o}C to +50 ^{o}C
- Operating Temperature - -20 ^{o}C to +60 ^{o}C
- Min. Bend Radius for Single Flexure - $\geq$ 40 mm
- Min. Bend Radius during Installation $\geq$ 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 – 8341

PUBLIC ADDRESS SYSTEM

1.0 SCOPE OF WORK

The work under this section consists of supplying, installing, testing and commissioning of all material and services of Public Address System as stated herein, as shown on Bidding Drawings and as given in the Bill of Quantities.

The Contractor will discuss the P.A System layout with the Engineer and coordinate at site with other services for exact route, location and position of electrical / telecommunication lines and equipment.

The Public Address 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

All equipment, cables and wires shall be numbered in accordance with the standardization procedures laid down in IEC 750.

Materials furnished under this specification shall be standard product of manufacturers, regularly engaged in the production of such equipment. Manufacturer shall also have authorized representative in Pakistan for maintenance of the equipment.

All the material and equipment shall be new and manufactured quality control shall be in accordance with the ISO 9000.

Public Address System shall interface with Fire Alarm System in accordance with NFPA72.

3.0 APPLICABLE STANDARDS AND CODES

DIN 4002, DIN 45573 and DIN 45589 shall be applicable for the material covered within the scope of this section.

4.0 MATERIAL

4.1 Microphone

The unidirectional microphone shall provide high quality speech intelligibility. It shall be suitable for either hand held or table mount. Microphone shall have 2-pole on/off slide switch and following minimum technical specifications.

Polar pattern	Unidirectional
Frequency range	100 Hz to 13kHz
Sensitivity	2mV/Pa
Cable length	5m

4.2 **Power Amplifier**

The power amplifier shall have four input channels mixer power amplifier, capable of wide variety of P.A requirements. Each input channel shall have its own volume and tone control, a selectable speech filter to reduce the bass content of the speech signal for improved intelligibility.

The power amplifier shall be protected against overload and short circuits. A temperature controlled fan shall ensure high reliability at high output power amplifier shall have an overheat protection circuit that switches off the power stage if the internal temperature reaches a critical limit due to poor ventilation or overload. The power amplifier shall have 70V and 100V outputs for constant voltage loudspeaker systems and a low impedance output for 8-ohm loudspeaker loads.

4.3 **Ceiling Speaker**

Ceiling Speaker suitable for flush mounting in different false ceiling systems, with round, square or rectangular covers plate as required shall be following minimum technical specifications:

- Rated output power: 6 W
- Sound pressure level: 91 dB at 1 metre distance at 1,000 Hz.
- Frequency response: 220 – 20,000 Hz.
- 100 V-transformer: easily adjustable in three solder less steps to 1/1, ½, and ¼ nominal output

Colour of the front grille as desired by the Architects.

4.4 **Wall Mounted Cabinet Speaker**

Wall mounted cabinet speaker suitable for mounting on wall brackets (supplied with the speaker) with square or rectangular front plate shall be used in Halls. These shall be supplied complete with 100V matching transformer adjustable in three steps of 1/1, ½ and ¼.

- Rated out power: 20 W
- Sound Pressure level: 113 dB at 1 meter distance at nominal output/1,000 Hz.
- Frequency response: 180-15,000 Hz.

Colour of the cabinet and front grills as desired by the Architects.

4.5 Loudspeaker Cable - Indoor

Multicore insulated and sheathed cables with minimum cross section of 1.5 sq.mm for the copper conductors. The conductor insulation and the sheath shall be polyvinyl chloride (PVC), and shall be rated for a minimum of 300/500 V, and shall comply with IEC 189.
The insulation resistance shall be a minimum of 10 kilo Ohm km.

The cable insulation shall be rated for at least 85^{o} C. The cables shall be suitable for the installation in conduits, ducts or on cable trays, and concealed under plaster. Number of conductors: as required.

4.6 Microphone Cable - Indoor

The conductors with a diameter of 0.5 mm shall be of stranded copper wires.

Two conductors shall be twisted to a pair, which is screened with tinned copper wires.

The conductor insulation and the sheath shall be polyvinyl chloride (PVC).

The insulation resistance shall be minimum of 100 Mega Ohm kW.

The cables shall be suitable for the installation in conduits, ducts or on cable trays. Number of pairs as required.

5.0 INSTALLATION

5.1 Public Address System Equipment

The installation of Public Address System Equipment shall be in strict accordance with the manufacturer's instructions/recommendations and these specifications.

5.2 Wiring and Cabling

Wiring and cabling of Public Address System shall be carried out as per instructions given in Section 8212 'Low Tension Cables' of these specifications.

5.3 Conduits and Accessories

Where concealed PVC conduit system is shown on drawings/ mentioned in BOQ, the conduit shall be installed concealed in roof, wall, column, etc. Conduits shall be laid under floor only where specifically stated. The entire conduit system shall be installed and checked before wring is carried out. Any obstruction found shall be cleared before the installation of cable.

When concealed, the conduit shall have a minimum of 32mm cover of concrete measured from the top of conduit to finished surface. In the reinforced cement concrete (RCC) work the conduit shall be laid before pouring of concrete. Under no circumstances shall chases be made in the RCC structure for concealing conduit and accessories after pouring of concrete. The conduit shall be supported on top of bottom reinforcement of slab. All outlet boxes to be firmly supported and installed such that they finish flush with the soffit of slab or beam.

Where conduits have to be concealed in cement concrete (CC) work after concreting or in block masonry, chase shall be made with appropriate tools and shall not be made deeper than required. The conduit shall then be fixed firmly in the recess and covered with cement concrete mixture. The work of cutting in the cement concrete work or block masonry work shall be coordinated with the civil work. The Contractor shall obtain approval from the Engineer before starting chasing and cutting.

Under floor conduit shall be installed at a minimum depth of 2 inch from the finished floor level or as shown on the drawings. The conduits shall be installed empty, before finishing of floor or in RCC work, with an 18 SWG steel wire drawn through the conduit for pulling cable. No conduits shall be laid under floor in bathroom.

The surface PVC conduits shall be installed where shown on drawings / mentioned in BOQ. The conduits shall be installed parallel or perpendicular to the surface of walls, structural members, ceiling, etc., by means of PVC saddles and clamps of approved design. The conduits shall be kept at least 150 mm away from parallel runs of flues, steam pipes and hot water pipes.

The saddles shall be installed on surface by means of nylon or wooden plugs and galvanized screws. Appropriate size of holes in structure shall made by drilling, the thickness of saddles and clamps shall be at appropriate thickness and prime quality.

6.0 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.

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 of all work specified herein and/or as shown on the Bidding Drawing related to the item.

7.2 **Speakers**

7.2.1 Measurement:

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

7.2.2 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 Speakers including all civil works and other accessories.

7.3 **Amplifier**

7.3.1 Measurement:

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

7.3.2 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, testing and commissioning of completion of the Amplifier including all installation accessories.

7.4 **Speakers/Microphone Cabling**

7.4.1 Measurement:

Measurement shall be made for the total running feet of Speakers/Microphone cabling acceptably supplied and installed by the Contractor.

7.4.2 Payment:

Payment shall be made for the total running feet measured as provided above at the Contract unit price each and shall constitute full compensation for supply, installing, testing and commissioning of the Speakers/Microphone cabling including all installation accessories.

7.5 **Conduit and Pipes**

7.5.1 Measurement:

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

7.5.2 Payment:

Payment shall be made for the total running feet 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

*** End of Section 8341 ***

PLUMBING WORKS

SECTION - 5100

PLUMBING

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 over flow 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^{o}C-200^{o}C	More than 2 cycles of thermal shock from hot to cold water 20^{o}C-110^{o}C
8	Durability	Permanently durable	Durable for ever

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^{o} 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^{o}F to 100^{o}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 ^{o}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 liting 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 automative 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 form 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 priemer 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+5º).

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 ($260^{o}C \pm 5$).
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 ±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. The assess the resistance of the fixed points one has to take into account the stresses to which they will be subjected, caused by linear expansion, weight of the piping and weight of the transportation fluid. Fixed points should be delimited on both sides of the clamp, availing oneself of the rim fittings or valves.

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.

Pipe diameter	***Temperature in ºC***		
	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, site, 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 atleast (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 the 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	PIPEWORKS Horizontal ($10xd_e$)	Vertical
(mm)	(m)	(m)
40	0.40	1.2
50	0.50	1.5
75	0.75	2.0
110	1.10	2.0

* The values shown are for general installations only. Attention is drawn to special requirements that may be needed in more demanding applications.

All steel clamps, hangers, supports etc. shall be given one coat of red oxide primer and two coats of synthetic enamel paint.

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 ***

SECTION - 5150

FIRE PROTECTION

SECTION - 5150

FIRE PROTECTION

1. SCOPE OF WORK

The work to be done under this section of the Specifications includes furnishing all plant, labour, equipment, appliances and materials and in performing all operations required in connection with the supply and installation of pipes and fittings for firefighting systems, portable fire extinguishers, fire hose rack cabinets and fire hydrants as shown on the Drawings, as specified herein and/or as directed by the Engineer.

2. APPLICABLE STANDARDS

Fire Fighting System shall conform to NFPA (National Fire Protection Association) of USA and/or Fire Safety provision-2016 Building Code of Pakistan.

3. SUBMITTALS

The contractor shall submit technical brochures and samples of all the items mentioned in the Specifications from approved manufactures or as directed by the Engineer

4. FIRE PROTECTION EQUIPMENTS

4.1 PIPES AND FITTINGS

Fire fighting pipes & fittings shall conform to ASTM A53/A53M steel line pipe “Steel Black and Hot dipped, Zinc Coated, Welded and Seamless Welded and Seamless Wrought Steel Pipe”. Joints shall be welded as specified in the applicable standards. Factory-Made Wrought Steel Butt-welding fittings shall conform to ANSI/ASME B16.9 and Butt-welding End shall be ASME B16.25 or any other standard specified in NFPA. Where the pipe flanges and flanged fittings are used, the applicable standard shall be ASME B16.5 or any other standard specified in NFPA.

4.2 FIRE HOSE CABINET

Closets and cabinets used to contain fire hose shall be of a size to allow the installation of necessary equipment at hose stations and designed so they do not interfere with prompt use of hose connection, the hose and other equipment at the time of fire. Fire Hose Cabinet shall consist of rubber hose/reel of specified diameter and length as shown on the applicable drawings and as directed. The hose shall have polished brass valve nozzle at one end. The reel shall turn full 180 degrees. Hose and reel shall be placed in a steel fire box with glazed steel door. The door shall open full 180 degrees and shall be provided with locking arrangement. The locking arrangement will be such that the cabinet can be opened either by breaking the front glass and turning the handle from inside or with key from outside without breaking the front glass. Where “break glass” type protective cover for latching device is provided, the device provided to break the glass panel shall be attached in the immediate area of the break glass panel and shall be arranged so that device cannot be used to break the other glass panels in the cabinet door. The glass shall be 5 mm thick and cabinet shall be made of at least 18 gauge sheet.

The exposed front face of fire hose cabinet shall be painted with signal red enamel paint over a prime coat of anti-corrosive paint. Instructions for opening of fire hose cabinets and operation of hose reel shall be inscribed in signal red on the inside face of the glass such that the instructions can be read from outside. The hose shall be rated for a working pressure of 16 kg/cm^2 and test pressure of 25 kg/cm^2.

4.3 EXTERNAL FIRE HYDRANTS/PILLAR HYDRANTS WITH HYDRANT CABINETS

Above grade wet barrel fire hydrant shall be cast iron or steel and shall conform to BS EN 671. It shall have 2 Nos. dia 2-1/2” (65mm) outlets suitable for connection of instantaneous coupling hose. It shall

have one suitable inlet connection of diameter 100mm for fire department pumper if specified in BOQ item. It shall be suitable for working pressure of 1.5 times the system working pressure.

The outlets shall be provided with protective standard caps of galvanized steel and attached to the standpipe by chains. The hydrants shall be coated internally and externally with black bituminous coating.

Each hydrant shall be provided with two 100 feet (30 meter) of 2-1/2" (65mm) diameter rubber lined hose instantaneous coupling and nozzles, all housed within a steel cabinet beside the hydrant.

Valve pits shall be of adequate size and readily/easily accessible for inspection, operation, testing, maintenance and removal of equipment contained therein. They shall be constructed and arranged so as to property protect the installed equipment from any ground movement and accumulation of water. The valve pits shall be precast concrete with reinforcement. Crushed stone or gravel shall be used for the floor of the pit. The pit covers shall be able to withstand the heaviest vehicle, which are using the roadside to be specified.

4.4 VALVES

All valves of Fire-fighting systems shall be as per standards and of specified pressure ratings.

4.5 PRESSURE REGULATING VALVE

Pressure regulating valve shall be as per standards and of specified pressure ratings. Approved pressure gauge shall be installed on both upstream and downstream sides of every pressure regulating valve device.

4.6 AIR RELEASE VALVES

These shall be designed to meet the following conditions:

- Expulsion of air during charging of the pipeline,
- Admit air during emptying of the pipeline to avoid the occurrence of negative pressure,
- Expulsion of air accumulated at summit points along the pipeline under normal operating conditions.

Air release valves shall be air cum vacuum release type to meet all the three conditions stated above and it shall be suitable for the liquid for which it is used. Valves body and cover shall be of Cast iron / malleable iron. Float and valve seat shall be of stainless steel. Valve ends shall be screwed or flanged as shown on the drawings. Threads shall be to B.S. 21 and flanges shall be drilled to B.S. 4504 Part 1. Air release valve shall be provided at all high points to ensure adequate venting of the piping system.

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5. PORTABLE FIRE EXTINGUISHERS

Portable fire extinguishers shall be maintained in fully charged and operable condition and shall be kept in their designed places at all times when they are not been used. Fire extinguishers having grossed weight not exceeding 40lbs (18.14 kg) shall be installed so that the top of extinguisher is not more than 5feet (1.53m) above the floor. Fire extinguishers having the gross weight greater than 40lbs (except wheeled types) shall be installed so that the top of extinguisher is not more than 3.5 feet (1.07m) above the floor. In no case shall the clearance between the hand portable fire extinguisher and floor be less than 4inch (102mm).

5.1 MATERIALS AND EQUIPMENT

Portable fire extinguishers shall contain specified quantities and types of extinguishing agents. Extinguishers shall be classified according to type of extinguishing agents and the Class of fire types for which it is intended to be used. The extinguisher container/vessel shall be of anticorrosive material or otherwise lined internally with corrosion-resistant material. The outside surfaces of the container/ vessel shall be painted with at least two coats of anti-corrosive paint.

The extinguisher container shall be designed as pressure vessel and shall conform to all the applicable standards of ASME pressure vessel codes.

The container shall be fitted with spring-loaded pressure safety valve. The valve shall be set to blow off at 90% of container test pressure.

5.2 CODES AND STANDARDS

Portable fire extinguishers shall conform to NFPA-10 (National Fire Protection Association) of U.S.A. or F.O.C. (Fire Offices Committee) of U.K. and B.S. 5423 or Fire Safety Provision 2016, Building Code of Pakistan.

5.3 LABEL VISIBILITY

Fire extinguishers shall be installed so that the fire extinguishers operating instructions faced outward. Portable Fire extinguishers shall be painted with colour code according to NFPA Standard specifications. On the body of the extinguishers shall be marked/imprinted the following information.

(a) Instructions on how to use the extinguisher.
(b) Name of the extinguishing agent.
(c) Weight/volume of the extinguishing agent.
(d) Gross weight of the extinguisher.
(e) Filling pressure of the extinguishing agent.
(f) Classes of fires for which the extinguishing agents may be effectively used.
(g) Name of the manufacturer and the year of manufacture.

5.4 INSPECTION FREQUENCY

Fire extinguishers shall be inspected at least once per calendar month. Fire extinguisher shall be inspected daily or weekly when conditions exist that indicate the need for more frequent inspections.

5.5 EXTINGUISHERS MAINTENANCE

Maintenance shall be done by manufacturer's service manual and thorough examination of mechanical parts, extinguishing agents, expelling means and physical condition. The extinguishers shall be subjected to maintenance at interval not more than one year. However the maintenance of type of extinguishers shall be at an interval specified in the applicable standards.

5.6 TYPES OF EXTINGUISHERS

5.6.1 Dry Chemical Extinguisher

Dry chemical extinguisher shall contain specified quantities of dry powder chemical. The type of dry powder shall be suitable for the intended use. The extinguisher shall have knob or lever operated valve, a short length of hose and a nozzle at the end of the hose. A siphon/dip tube shall extend from the valve to the bottom of the container. The valve shall have safety pin to prevent accidental release of the extinguishing agent. The discharge pressure shall be obtained from pressurized carbon dioxide cartage attached to the body of the extinguisher. The operation of the knob or lever shall pierce the cartage to obtain the expellant pressures. When operated the discharge time of 6 kg dry powder extinguisher shall not be less than 14 seconds and max range of throw shall be not less than 5-8 meter.

5.6.2 Foam Extinguisher

Foam extinguisher shall contain specified quantities of premixed foam of 1 liter of water, the extinguisher shall be pressurized with nitrogen. The extinguisher shall have a short length of hose and a valved nozzle. The valve shall have safety pin to prevent accidental release of the extinguishing agent. The extinguishers shall be self-expellant. In no case antifreeze additive shall be used.

When operated, the throw for 9 liters foam extinguisher shall not be less than 6 meters. The discharge time shall not be less than 40 seconds.

5.6.3 Wet Chemical Fire Extinguisher

Wet chemical fire extinguishers are recommended to extinguish Class-K fires. The extinguishing agent can be comprised of, but is not limited to, solution of water and potassium acetate, potassium carbonate, potassium citrate or a combination of these chemicals. The liquid agent typically has a pH of 9.0 or less. On class K fire, the agent forms a foam blanket to prevent re-ignition.

The extinguisher shall have knob or lever operated valve, a short length of hose and a nozzle at the end of the hose. The valve shall have safety pin to prevent accidental release of the extinguishing agent.

5.7 INSTALLATION OF EXTINGUISHERS

Portable fire extinguishers shall be installed at one meter height above finished floor. Where only extinguishers are installed they shall be fixed to wall or column with painted steel clamps or stored in steel or concrete fire extinguisher cabinets as shown on the applicable drawings or as directed by the Engineer. Where clamped to the wall/column the clamp shall be such that extinguisher can be conveniently fixed and removed without loss of time.

Where stored in cabinets, the cabinets shall be of steel or concrete with glazed steel door painted with at least two coats of anti-corrosive signal red enamel paint over a prime coat of red oxide paint. The locking arrangement will be such that the door can be opened from inside by breaking the glass and from outside with key.

System should be tested and commissioned as per NFPA requirement or any other applicable standard.

6. INSTALLATION AND TESTING OF PIPES

6.1 GENERAL REQUIREMENTS

The Contractor shall submit to the Engineer for approval of the following information regarding the specified/proposed items of pipes and fittings.

i. Name and address of the manufacturers
ii. Country of origin, make and model
iii. Dimensions and wall thicknesses of pipes and fittings
iv. Material and thicknesses of coating and lining
v. Factory test certificate from the manufacturers (MTC)
vi. Warranty if so provided by the manufacturers
vii. Method of jointing, testing and commissioning

Every pipe shall be tested at the manufacturer's works to specified hydraulic test pressure. The test pressure shall be maintained for sufficiently long time for proof and inspection. Each pipe and fitting shall be permanently marked or engraved giving the following information:

(i) Make and Nominal diameter
(ii) Class, Duty or Service (Pressure) Rating
(iii) Standards according to which the pipes and fittings have been manufactured.

Unless otherwise specified diameters of pipes and fittings shall be nominal. Actual inside and outside diameters and tolerances in diameters of pipes and fittings shall be according to the specified standards. Unless otherwise specified, service ratings of pipes and fittings shall not be less than the maximum pressure to which they will be subjected to.

Unless otherwise specified, wall thicknesses of the pipes shall be according to the class, schedule or duty of the pipes. The wall thicknesses shall be measured at locations excluding the jointing ends.

The tolerances in wall thicknesses shall be according to the specified standards. Wall thicknesses of fittings shall not be less than those of corresponding pipes to which they are joined together. Unless otherwise approved by the Engineer, pipes and fittings, jointing materials such as rubber rings, gaskets, nuts & bolts and jointing compound etc. shall be of the same manufacturers as those of the pipes and fittings.

6.2 TRANSPORTATION, HANDLING AND STORAGE

The Contractor shall be responsible for proper transportation, handling (loading and unloading) and storage of pipes and fittings as per the manufacturer's recommendations and direction of the Engineer.

Crane, rope or nylon slings, lifting beams with flattened hook scissor-dog shall be used for loading and unloading of pipes fittings. Hooks and dogs shaft be well padded to prevent the pipe being damaged and shall be fitted-with locking device. Steadying ropes essential.

Pipes and fittings damaged during transportation, handling or storage of lowering shall be rejected and replaced at the Contractor's expense storage of gaskets and jointing compound shall be under shade to prevent damage by sunlight and extreme heat.

6.3 INSPECTION

Pipes and fittings shall be visually inspected for any evidence damage or hair cracks. The turned ends of pipes and fittings shall be inspected for any local irregularities, which could affect the water tightness of the joint. Damaged pipes and fittings shall be rejected and replaced at the Contractor’s expense.

6.4 LAYING OF PIPES

6.4.1 Above Ground (Unburied)

Before installation, the interior of pipes and fittings shall be thoroughly cleaned of all rust, dirt and foreign materials. Pipe and fittings shall be installed to lines and grades as shown on the drawings and/or as directed by the Engineer.

Pipe joints shall be welded unless otherwise specified and/or directed by the Engineer except for jointing valves and appurtenances and where welding is not possible. Welding shall be done by qualified and licensed welders using electric arc welding process. The welding shall develop full strength of the adjoining steel. Defective joints and joints not developing full strength shall be rejected at the risk and cost of the Contractor.

Pipes and fittings shall be properly supported by galvanized steel clamps, brackets and hangers, etc. Supports shall permit unrestrained expansion and contraction. Clamps, brackets and hangers etc. shall be designed to take the weight of pipe, weight of water, seismic and wind loads.

Thrust anchors shall be provided at all changes in the pipe diameters and directions and at all branches and dead ends. Thrust anchors shall be designed to resist maximum thrust forces resulting from the worst possible combination of working/static/test pressures, transient/water hammer pressure, and thermal expansion/contraction, seismic and wind loads.

The Contractor shall submit to the Engineer for approval shop drawings of the pipes supports and thrust anchors. The supports and anchors shall be used only after approval by the Engineer. Approval by the Engineer shall however, not relieve the Contactor from any of his contractual responsibility regarding safety requirements of the supports and anchors.

Pipes passing through floors, ceilings, roof, walls and columns in non-water retaining structures above ground or water table shall be encased in black steel pipe sleeve. The annular space between the pipes and the pipe sleeves shall not be less than one inch. The annular space shall be filled with approved packing material and sealed at both ends with

approved fire rated sealant.

Pipes passing through water retaining structures above or below ground and non-water retaining structures below water table shall be provided with leak proof puddle flange. The flange diameter shall be larger than the outside diameter of the pipe by at least 4” for pipe diameters 6” and smaller and by at least 6” for pipe diameters larger than 6”.

After installation, pipes, fittings, pipe supports and thrust anchors shall be painted with two coats of red oxide or zinc chromate primer and two coat of synthetic enamel paint of approved quality.

6.4.2 Below Ground (Buried)

Before installation, the interior of pipes and fittings shall be thoroughly cleaned of all rust, dirt and foreign materials. Pipes and fittings shall be laid to alignments and grades as shown on the drawings and/or as directed by the Engineer. Pipes and fittings shall be lowered into the trench in a manner approved by the Engineer. All care shall be taken to avoid abrasion of the pipes and fittings.

The pipes shall be laid on specified bedding material. Before laying bedding material shall be approved by the Engineer. Recesses shall be excavated in the bottom and sides of the trench to accommodate joints, fittings and specials. After laying of pipe and fittings, the recesses shall be filled with specified bedding material and thoroughly compacted manually. Pipes and fittings alignments, that have the grades or joint disturbed or dislocated after laying shall be removed and re-laid to the entire satisfaction of the Engineer.

Backfilling shall be carried out with the specified materials and in the specified sequence. Backfill shall be laid in layers and compacted to 95% of AASHTO modified density. The thickness of each compacted layer shall not exceed 6”. Hand tools shall be used for compaction of backfill/bedding material around the pipe and fittings. Mechanical methods may be used for compaction of backfill 12” over/above crown the pipeline.

When laying is not in progress, the open ends of the pipeline shall be closed with a temporary plug as approved by Engineer. Small changes in direction may be made by deflecting the last laid pipe after the joint has been made. If the alignment requires deflection in excess of the manufacturer's recommended limits, bends shall be used. Concrete thrust blocks shall be provided at all changes in the pipe diameters and directions and at all branches and dead ends.

After installation, pipe and fittings shall be applied with two coats of bituminous paint and wrapped with soaked bitumen hessian cloth. Alternatively pipe and fittings shall be double wrapped with bituminized tape.

6.5 JOINTING OF PIPES & FITTINGS

Welding shall be permitted as a mean of jointing pipes and fittings. The welding process shall be performed in accordance to NFPA-51B. Welding shall not be performed where there is impingement of rain, snow, sleet or high wind on the welded area of pipe product. Torch cutting and welding shall not be permitted as a means of modifying or repairing Fire-fighting system.

Weld between pipes and welded outlet fitting shall be permitted to be attached by full penetration welds, partial penetration groove welds or fillet welds. The minimum throat thickness shall not be less than the thickness of pipe, thickness of welded fitting or 3/16 inch (4.5mm) whichever is least. Circumferential butt joints shall be cut, beveled and fit so that full penetration shall be achieved. Face welds on the internal face of flange shall be permitted as a water seal in addition to hub weld.

When welding is performed, the following shall be applied: Holes in piping for outlets shall be cut to the full inside diameter of fittings prior to welding. Discs shall be retrieved. Openings cut into piping shall be smooth bore and all internal slag and welding residue shall be removed. The fittings shall not penetrate the internal diameter of piping. Steel plated shall not be welded to the ends of piping or fittings. Fittings shall not be modified. Nuts, clips, eye rods, angle brackets or other fasteners shall not

be welded to pipe or fittings. Completed welds shall be free from cracks, incomplete fusion,surface porosity. Completed Circumferential butt weld reinforcement shall not exceed 3/32in (2mm).

6.6 TESTING

After laying each section of pipeline as convenient to the contractor or as necessary in the Engineer's opinion, shall be tested for hydrostatic pressure. Field hydrostatic test pressure shall not be less than 1-1/2 times the maximum pressure to which the system will be subjected to.

Before testing, pipe section shall be cleaned and their ends shall be closed with blank flanges, plugs or caps. The closed ends shall be anchored against thrust forces. Valve air vent outlet shall be installed at the upper end of the pipe section and valve water inlet fitting shall be installed at the lower end of the section. Pressure gauge certified from any approved laboratory shall be installed at both lower and upper ends of the pipe section. An isolating ball valve shall be fitted between the pipe section and the gauges.

Sufficient backfill material shall be placed over the center section of each pipe (leaving the joints exposed) to allow inspection of the pipe joints under the test pressure. All permanent anchors shall be in positions and shall have developed adequate strength before the testing begins. The pipe section under test shall be filled with water from the inlet fitting, taking care that all air is displaced through the vent outlet.

After filling, the pipeline shall be left under small pressure for 24 hours as directed by the Engineer in order to wet the pipe and the pipe joints. After the wetting period, additional water shall be introduced into the pipe section until the test pressure is achieved when the pipe section shall be closed.

The test pressure shall be maintained for at least two hours or for a period as directed by the Engineer. Pressure gauges shall be read at maximum intervals of 15 minutes during the test period.

If the pressure measurements are not made at the lowest point of the section, an allowance shall be made for the static head between the lowest point and the point of measurement to ensure that the specified works test pressure is not exceeded at the lowest point.

If a drop in pressure occurs, additional quantity of water shall be introduced into the pipe section in order to re-establish the test pressure. The additional quantity of water introduced into the pipe section shall be accurately measured.

During the test period all joints shall be inspected. If any abnormal movement, distortion, squirm or leakage is detected, the test pressure shall be relieved immediately and the defects shall be rectified in consultation and with the approval of the Engineer. After rectification of the defects, the pipe section shall be re-tested.

The test will be considered to have passed, if the quantity of water required to be added the test pressure does not exceed 100 liters per day, per meter of diameter and per kilometer of pipeline for each 30 meters head of test pressure.

6.7 FLUSHING AND COMMISSIONING

After installation and testing pipelines shall be flushed with water until all dust, dirt, scales and extraneous matters are removed from the inside of the pipeline. During flushing all valves and appurtenances shall be closed and open several times.

After successful completion of testing and flushing duly approved by the Engineer, pipelines shall be commissioned. All valves and appurtenances shall be set at proper openings and all parameters shall be set at specified or manufacturers' recommended values.

6.8 PIPEWORK SUPPORTS

All pipe work supports shall be of mild steel rolled sections and shall be painted with two coats of

approved rich metallic zinc primer. Straps, rods and hangers shall be of mild steel when used for galvanized steel pipes.

Straps shall be provided on all pipe supports. Straps 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 allowing the pipe to slide axially.

Horizontal pipe work along 'walls shall be supported on channel frames securely fixed to the column. All pipes shall be arranged to slide on the pipe supports and straps shall be provided to form a rigid guide.

Vertical pipe work shall be supported at the base or at anchor point to withstand the total weight of the riser. Brackets from risers shall not be used as a means of support for the riser.

Pipe work supports shall be so designed and installed as to allow free movement due to expansion and contraction. Supports shall be anchor to steel or reinforced concrete column, wall, beam or slab.

Each support shall be able to carry independently its all the operational loads of pipe work and water.

All pipes shall be individually supported. Pipes shall not hang from other pipes. Points at which pipes pass through walls, floors, connections to plan equipment and heat emitters, etc. do not constitute points of supports for the pipes.

Provide suitable and substantial hangers and supports for all piping. As a minimum for metallic pressure piping, support schedule shall be as follows:

Pipe Size	Maximum hanger spacing (feet)	Rod Sizes (inches)
1 inch and smaller	6	3/8
1-1/4 inch to 2 inch	8	3/8
2-1/2 inch to 4 inch	10	3/8
5 inch and larger	12	1/2

7. MEASUREMENT AND PAYMENT

7.1 MEASUREMENT

Measurement of acceptable completed works of every component of fire-fighting system will be made on the basis of material/equipment provided and installed in accordance with the above specifications and applicable drawings.

7.2 PAYMENT

Payment for acceptable measured quantities of every component of fire-fighting system will be made on the basis of unit rate of material/equipment quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

*** End of Section 5150 ***

SECTION – 5216

WATER SUPPLY PIPES, PIPE LAYING AND APPURTENANCES

1.0 SCOPE

The work covered by this Section of the specification consists in furnishing all plant, labour, equipment, appliances and materials and in performing all operations in connection with water supply lines and appurtenances in strict accordance with this section of the specifications and the applicable Drawings.

2.0 MATERIALS

Material shall conform to the respective specifications and other requirements specified hereinafter and shall be new and unused.

2.1 Galvanized Iron Pipes and Fittings (BS standards)

These galvanized iron pipes shall strictly conform to B.S. 1387 Specifications for "Steel Tubes and Tubulars suitable for screwing to B.S. 21 pipe threads" and shall be of medium grade. All screwed pipes and sockets shall conform B.S. 1740. A complete and uniform adherent coating of zinc white will be provided for galvanized iron pipes and fittings.

2.2 MS/Galvanized Iron Pipes and Fittings (ASTM standards)

These pipes shall conform to ASTM designation A53, schedule 40 "standard specification for welded and stainless steel pipe".

Short pieces shall be flanged at both ends. The flanges shall conform to B.S. 4504, part 3 (PN 16). M.S. pipe pieces shall be externally protected by applying two coats of red oxides (of approved quality) and bituminous coating (grade 10/20) at the rate of 0.4 lb/Sq.ft.

2.3 Polyethylene (HDPE) Pipes

Polyethylene Pipes and fittings shall conform to ISO 4427:1996, DIN 8074/8075, PE-100 of specified pressure rating (PN-10, PN-12.5, PN-16).Material, diameters, wall thickness shall be as indicated in identified standards. Tests to be performed in factory for pipes shall be Heat revision, Short term hydrostatic pressure test and Tensile strength. Fusion welding shall be performed as per ISO 4427 and DVS 2207-1 by specified firms.

Warning tape shall be provided for laying over PE pipes. It should be single fold, 0.02 inch thick and 2 inch wide, with warning for digging continuously printed in approved language. The tape shall be placed one foot above the PE pipe.

2.4 Sluice (Gate) Valve

Valves shall be wedge gate valves conforming to British Standard Specification 5163. Ends of valves shall be suitable for the type of pipe to which the valves will be connected.

2.5 Check Valves

Check valve shall comply with the requirements of BS 5153 latest revision for pressure rating of 16 bar. The valve shall be of swing type and shall be of quick acting single door type.

2.6 Fire Hydrants

The metal of the fire hydrant shall conform to B.S. 750 and shall be of screw down streamline pattern. The body shall be best quality, closed grain, grey cast iron with spindle of manganese bronze having tensile strength of not less than 11.0 tons per square inch machined from solid rolled bars, the seating valves and other parts shall be of best quality gun metal with Brinell Hardness No. 80. The direction of closing shall be by clockwise rotation and outlet shall have screwed joint for accommodation 2 1/2" dia hose connection. Inlet flanges of hydrant shall be suitable for jointing with flanges of hydrant bends and tees. All fire hydrants shall be coated with three coats of solution from an approved manufacturer to give a uniform protective coating on cast iron.

3.0 APPROVAL OF MATERIALS AND EQUIPMENT

As soon as practicable but within 30 days after receipt of notice to proceed and before any materials or equipment are purchased, the Contractor shall submit for approval by the Engineer a complete schedule, in triplicate, of materials and equipment to be incorporated in the work, together with the names and addresses of the manufacturers and their catalogue cuts, diagrams, drawings, and such other descriptive data as may be required by the Engineer. No consideration will be given to partial lists submitted from time to time. Approval of materials and equipment under deviations from the specifications shall not be granted unless the attention of the Engineer has been directed to the specific deviations. Laboratory results and certifications, specified or otherwise required, shall be submitted prior to delivery of the material and equipment to site.

4.0 INSTALLATION

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.

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.

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.

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 for Asbestos Cement Pipe unless other- wise 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 setforth, as approved.

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 chaulking or jaunting 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.

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.

4.7 Setting of Fire Hydrants, Valves and Surface Boxes

Fire hydrants shall be located and installed, as shown. Hydrants shall be set plumb and in accordance with the manufacturer's instructions.

Valves and surface boxes shall be installed as shown or directed, and shall be set plumb. Surface shall be centered on the stems or operators. Concrete, concrete pipe, brick, brick ballast used in chambers shall conform to the relevant clause of the Specification. Where feasible, valves or operators shall be located outside the area of roads and streets. Earth fill shall be carefully tamped around each valve box to the satisfaction of Engineer on all sides of the box, or to the undisturbed trench face if less than 4 ft.

Hydrants and valves shall have the interiors cleaned of all foreign matter before installation. Surface boxes shall be lighted and the hydrant or valve shall be inspected in open and closed positions to ensure that all parts are in working condition.

4.8 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.

4.9 **Pipe Bedding**

Fine sand as pipe bedding material shall be used for A.C. pipe and C.I. fittings. The sand shall be free from clay, site, salts, organic impurities and debris. Approval of pipe bedding materials shall be obtained by the site Engineer prior to placing.

4.10 **Pavement Restoration**

The Contractor shall restore paved surface which have been cut under this contract, as part of the work under the excavation items and at no extra cost to the owner/employer.

5.0 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.

6.0 LEAKAGE TEST

Flushing of the pipeline shall be followed by a leakage test. The Contractor shall provide facilities for performing the leakage test. Water and pumping facilities shall be provided by the Contractor. Before the testing of pipeline, the Contractor shall ensure that concrete backing blocks have been provided where necessary. The test shall be performed only after all concrete work in contact with pipe to be tested has set for a minimum of 24 hours. All joints shall be left exposed. Leakage test shall be performed by keeping the end of the pipeline closed by proper plugs blocked to resist 150 per cent of the working pressure. While filling the line all valves and openings shall be kept open and water shall be filled in slowly. When the pipeline is completely filled with water and all air expelled, water shall be pumped into the pipeline to a minimum pressure of 150 percent of actual working pressure and the test pressure shall be maintained for at least 1 hour. Each and every joint shall be inspected for leaks and for all visible leakage and displacement leakage test shall be performed by the Contractor, for the

newly laid pipeline. A measured quantity of water shall be pumped into the pipeline. No piping installation will be accepted until the leakage is equal or less than the number of imperial gallons per hour as determined by the formula:

$$L = 0.00054\ ND / P$$

L = Leakage in Imperial Gallons

N = Number of joints

D = Nominal diameter of pipe in inches

P = Average test pressure (psi) during test

In the event of the pipeline failing the leakage test, the Contractor shall locate and repair the defective pipe, fitting or joint at his expenses. For dewatering the line for repairs the Contractor shall follow the instructions given by the Engineer for disposal of water. After repairs of the line, the Contractor shall retest the line. The line will not be accepted until it passes the leakage test.

7.0 RETESTING AFTER BACKFILL

After the pipe trench has been backfilled, the entire length shall be subjected to a leakage test as a whole unit. The Contractor shall repair the line if it fails to pass the leakage test requirements specified hereinbefore. The test shall be repeated and repairs affected until the pipeline passes the leakage test.

8.0 PIPELINE DISINFECTION

8.1 General

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.

8.2 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.

8.3 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.

8.4 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.

9.0 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.

10.0 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 resampling and retesting shall be recovered from the Contractor.

11.0 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

12.0 WASHOUTS

The design and locations of washouts shall be illustrated on the Drawings to be approved by the Engineer. Exact positioning shall be determined with regard to topography and to the approval of the Engineer. At least 10 ft. of the washout pipe work, inclusive of the isolating valve, measured from the centre line of the pipeline, shall be laid at the same time as the pipeline and suitably capped to

prevent ingress of foreign material. The minimum gradient for the washout pipe work shall be 1 in 100.

13.0 AIR VALVES

a) **Double orifice Air Valves**

These shall be designed to meet the following conditions:

- expulsion of air during charging of the pipeline
- admit air during emptying of the pipeline to avoid the occurrence of negative pressure
- expulsion of air accumulated at summit points along the pipeline under normal operating conditions

First two conditions shall be met by the employment of a large orifice capable of handling large volumes of air at high flow rate, and the third condition by a small orifice capable of discharging small quantities of air as they accumulate.

The large orifice shall be sealed by a buoyant rigid ball and the chamber housing shall be designed to avoid premature closing of the valve by the air whilst being discharged. The small orifice shall be sealed by a buoyant ball at all pressures above atmospheric except when air accumulates in the valve chamber.

b) **Single Orifice Air Valves**

These shall be designed to carry out the function described above. Each valve shall be provided with only a small orifice which shall operate in the same manner as that in a double acting air valve.

Valves with air intake or exhaust facilities shall have approved screening arrangements to prevent the ingress of air borne sand.

The nominal pressure shall range between NP 16 and 25.

Body ends shall be flanged with raised faces and drilled according to BS 4504 for the nominal pressure specified or indicated in the Drawings.

The materials for the valves shall be as follows:

Cast iron body cover and cowl: for small orifice, cast iron with gunmetal seat with rubber covered ball or other approved; for large orifice, cast iron with rubber seat and vulcanite covered ball or other approved.

14.0 MEASUREMENT AND PAYMENT

Measurement and payment of pipe work, fittings, specials and appurtenances will be made in accordance with the provisions of this clause specified hereinafter.

14.1 Pipe work

a) **Method of Measurement**

Measurement will be made for the number of running feet of pipes including fittings, accessories and flanges acceptably installed complete in all respects as per relevant Drawings or as directed by the Engineer or manufacturer.

b) **Basis of Payment:**

Payment will be made for the running feet of pipework as measured above at the Contract Unit price and shall constitute full compensation to provide, handle, lay and joint pipes including fittings, flushing, leakage testing before & after backfilling, final flushing and all other work related to the item.

14.2 Service Connection

i) G.I. Pipe and Fittings

a) **Method of Measurement:**

Measurement will be made for the number of linear feet of galvanized iron pipe including fittings acceptably installed complete in all respects as per relevant Drawings or as directed by the Engineer.

b) **Basis of Payment:**

Payment will be made for the number of linear feet of galvanized iron pipe work as measured above at the Contract Unit Price of each unit and shall constitute full compensation to provide, handle, lay, joint and test galvanized iron pipe, fittings, including sleeves, nuts, sockets, plugs, bitumen coating with Polyethylene tape and all other work related to the item.

ii) **Ferrule Assembly**

a) **Method of Measurement:**

Measurement shall be made for the number of ferrules acceptably installed complete in all respects as per relevant Drawings or specifications.

b) **Basis of Payments:**

Payment shall be made for the number of ferrules measured as above at the contract unit price for each unit and shall constitute full compensation for providing, tapping, drilling, fixing including M.S. straps, Saddles, and all other work related to the item to make complete house connection.

14.3 **Sluice (Gate) Valves**

a) **Method of Measurement:**

Measurement will be made for the number of sluice (gate) valves acceptably installed complete in all respects as per relevant Drawings.

b) **Basis of Payment:**

Payment will be made for the number of sluice (gate) valves measured as above at the Contract Unit Price for each unit and shall constitute full compensation for providing, handling, fixing and jointing and all other work related to the item including construction of chamber as shown on drawings.

14.5 **Fire Hydrants**

a) **Method of Measurement:**

Measurement shall be made for the number of fire hydrants acceptably installed complete in all respects as per relevant Drawings.

b) **Basis of Payment:**

Payment will be made for the number of fire hydrants measured as above at the Contract Unit Price for each unit and shall constitute full compensation for providing, handling, fixing and jointing and all other work related to the item including construction of chamber.

14.6 **Washouts**

a) **Method of Measurement:**

Measurement will be made for the number of washouts acceptably installed including construction chamber completes in all respects and as approved by the Engineer.

b) Basis of Payment:

Payment will be made for the number of washouts measured as above at the contract unit price for each unit and shall constitute full compensation for providing handling, fixing and all other work related to the item including construction of chamber.

14.7 **Air Valves**

a) **Method of Measurement:**

Measurement will be made for the number of air valves acceptably installed complete in all respects and as approved by the Engineer.

b) Basis of Payment:

Payment will be made for the number of air valves measured as above at the contract unit price for each unit and shall constitute full compensation for providing handling, fixing and jointing related to the item including construction of chamber.

14.8 **Sand Cushion**

a) **Method of Measurement:**

Measurement will be made for the number of cubic foot of sand acceptably placed complete in all respects and as approved by the Engineer.

b) **Basis of Payment:**

Payment shall be made for the number of cu.ft of sand measured as provided above at the contract unit price per cu.ft and shall constitute full compensation for all work related to the item.

14.9 **Thrust Blocks**

a) **Method of Measurement:**

Measurement will be made for the number of cubic foot of class ‘C’ concrete acceptably placed complete in all respects and as approved by the Engineer.

b) **Basis of Payment:**

Payment shall be made for the number of cu.ft of class ‘C’ concrete measured as provided above at the contract unit price per cu.ft and shall constitute full compensation for all work related to the item.

14.10 **Concrete Encasement**

a) **Method of Measurement:**

Measurement will be made for the number of cubic foot of class C concrete acceptably placed complete in all respects and as approved by the Engineer.

b) **Basis of Payment:**

Payment shall be made for the number of cu.ft of class C concrete measured as provided above at the contract unit price per cu.ft and shall constitute full compensation for all work related to the item.

*** End of Section 5216 ***

SECTION 5220

VALVES AND APPURTENANCES

1.0 SCOPE

The work under this section of the specification consists of furnishing all plant, labour, equipment, appliances, materials and performing all operations required as specified herein, as shown on the drawings, or as directed by the Engineer, in connection with installation of valves.

2.0 APPLICABLE STANDARDS

Cast Iron gate valves	BS-5163
Cast iron check valves	BS- 5153
Bronze gate valves	BS- 5154
Bronze check valves	BS- 5152
Flexible rubber joint	BS- 5155
Float valves	BS- 1212

3.0 SUBMITTALS

The contractor shall submit technical brochures and samples of all the items mentioned in the Specifications from approved manufactures or as directed by the Engineer

4.0 MATERIAL & EQUIPMENT

4.1 DESCRIPTION

All valves shall be of renowned manufacturer as specified. Valve material shall be suitable for installation on potable water lines, sewage line or sludge piping. Service rating of the valves shall be at least 7 bars to 16 bars. The interior of all valves shall be cleaned of all foreign material before installation.

Valves shall be installed at the position indicated in the Contract Documents or as directed by the Engineer. Valves shall be adequately supported. Installed valves shall be subjected to pressure and leakage tests and no leakage shall be observed under these tests. End joints, flanges, etc., shall be of the appropriate class and material.

Valves shall be installed either in chambers or above grade on line as shown in the Contract documents and/or as specified herein. Valves shall be securely anchored.

Open and closed position indicator shall be provided for all valves. If installed in valve chambers, the indicator shall not extend above ground and shall not interfere with opening or closing of the valve. The indicator design shall be approved by the Engineer before installation.

4.2 CAST IRON GATE VALVES

Cast iron gate valves shall have flanged ends and wheel handle and shall conform to B.S.5163 "Specifications for Double Flanged Cast Iron Wedge Gate Valves for Waterworks purposes". Flanges shall be drilled to B.S. 4504 Part 1. Valves shall be rated for a working/service pressure of 16 bars for water supply system and 25 bars for firefighting system. Valves shall close in clockwise direction.

The valve parts shall be of the following materials.

- Valve body shall be of cast iron.
- Flanges shall be of cast iron.
- Shaft shall be of stainless steel.
- Disc shall be of stainless steel with bronze trim.
- Seat shall be of cast iron with bronze trim.

4.3 CAST IRON CHECK VALVES

Cast iron check valves shall be of non-slam, swing type with flanged ends and shall conform to B.S. 5153, "Specifications for Cast Iron Check Valves for General Purposes". Flanges shall be drilled to B.S. 4504 Part 1. Valves shall be rated for a working/service pressure of 16 bars. The direction of flow shall be permanently marked on the body of the valve.

The valve parts shall be of the following materials.

- Valve body shall be of cast iron.
- Flanges shall be of cast iron.
- Shaft and spring shall be of stainless steel.
- Disc and seat shall be of stainless steel with bronze trim.
- Disc and shaft seal shall be of rubber (O-ring type).
- Wheel handle shall be of cast iron.

Valve parts in contact with water shall be of corrosion resistant material, free from toxic substances and shall not foster microbiological growth or impart taste, odor, turbidity or color to the water.

Inside surfaces of valves shall be enameled and outside surfaces shall be epoxy coated.

4.4 BRONZE GATE VALVE

Bronze gate valves shall conform to B.S. 5154, "Specifications for Copper Alloy. Globe, Globe Stop, Check and Gate Valves for General Purposes". Valves shall be rated for a working/service pressure of 16 bars. Valve ends shall be screwed or flanged as shown on the drawings. Threads shall be to B.S. 21 and flanges shall be drilled to B.S. 4504 Part 1. Valves shall close in clockwise direction. Open and shut indicators shall be marked on the wheel handle.

4.5 BRONZE CHECK VALVES

Check valves shall conform to B.S. 5152 "Specifications for bronze check valves for general purposes". The service rating shall be 16 bars. The direction of flow shall be permanently marked on the body of the valve. Body of valve shall be tested to 1-1/2 times the service rating and seat shall be tested to service rating. No leakage shall be permitted under the above tests check valves shall be of swing type.

End of the valves shall be flanged to joint with the standard fittings. Flanges shall be of appropriate class and material. Valves shall be installed at positions shown on the drawings the interior shall be cleaned

of all foreign matter before installation. They shall be inspected to ensure that all components are sound and in working condition.

4.6 AUTOMATIC AIR VENT VALVE

Automatic Air Vent valve shall be of PN-16 Brass or bronze body (made in Italy), of specified size for automatic discharge of air and for automatic breaking of vacuum in a pressure main. The material used shall be corrosion resisting, growth. Each valve shall be installed with an isolating gate valve, stand pipe, clamp and connection with the line.

4.7 FLEXIBLE RUBBER JOINT

Flexible rubber joint shall be threaded union type of PN-16 conforming to BS 5155, of specified size for installation in water supply line crossing building expansion joint or at the locations as marked on drawings or as directed by the Engineer. The material used shall be corrosion resisting.

4.8 FLOAT VALVE

Float valve shall be of copper alloy, piston type and shall conform to B.S. 1212. Float shall be of copper and shall conform to B.S. 1968.

4.9 SINGLE ACTING AIR VALVE

Air release valves shall be single acting (air cum vacuum release) type suitable for the liquid for which it is used. Valves body and cover shall be of malleable iron. Float and valve seat shall be of stainless steel. Valve head shall be of Viton (Synthetic Rubber). Valve ends shall be screwed or flanged as shown on the drawings. Threads shall be to B.S. 21 and flanges shall be drilled to B.S. 4504 Part 1.

Air release valve shall be provided at all high points to ensure adequate venting of the piping system.

4.10 WATER METER

Water meter shall be of turbine/ vane type .the body shall be of fine grained cast iron with black enamel coating. Ends shall be flange shall be rated for 16 bars working pressure. The normal flow rate shall range from 50 cu.m/hr. to 300 cu.m/hr.

4.11 INSTALLATION OF VALVES, TESTING & COMMISSIONING

Valves shall be installed either in chambers or above grade on line as shown on the drawings and as directed by the Engineer. Before installation, the interior surfaces of valves shall be cleaned of all foreign matters, inspected to ensure that all components are sound and in working condition and tested to 1-1/2 times the working pressure or the service pressure whichever is greater. After installation, valves shall be securely anchored; tested, retouched where paints have been damaged and labeled.

5.0 DELIVERY, STORAGE & HANDLING

Valves should be handled and stored properly to avoid any damage and slippage of threads especially during installation.

6.0 MEASUREMENT AND PAYMENT

6.1 General

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

a. Jointing arrangement of pipe on both ends of valves, including gaskets, nuts, bolts etc.
b. Valves and appurtenances supports and anchors
c. Keys for operation of valves
d. Steel embedded parts and label plates
e. Manufacturer's literature and operation manual for valves and appurtenances
f. Painting of valves, water meter and appurtenances
g. Stand pipe and coupling for underground fire hydrants

6.2 Measurement:

Measurement of acceptable completed works of all types of valves, water meter and above ground fire hydrants will be made on the basis of actual number of valves and above ground fire hydrants provided and installed in position as shown on the drawings, and as directed by the Engineer.

6.3 Payment:

Payment for the acceptable measured quantity of all types of valves, water meter and above ground fire hydrants will be made on the basis of unit rate per number quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

*** End of Section 5220***

SECTION 5230

MANHOLE COVERS, ROAD GULLY GRATINGS AND FRAMES FOR DRAINAGE PURPOSES

1. SCOPE OF WORK

The work to be done under this section of the specifications consists of furnishing all plants, labour, equipment, appliances, material and performing all operations required in connection with supply and installation of C.I cover with frame, complete as specified herein, as shown on the drawings and or as directed by the Engineer.

All cast iron covers and frame shall be of the sizes and grade (or duty) as specified on the drawings. The specified size means the clear opening. The cover shall be complete with frame. Top of cover shall be roughened in an approved pattern. Locking and lifting arrangement shall also be provided. The frame shall be well in place at the time of pouring of concrete. The cover shall tightly fit in the frame. It shall be air tight and water tight.

2 APPLICABLE STANDARDS & SUBMITTALS

Manhole covers with frame BS-497

3. SUBMITTALS

The contractor shall provide samples and literature for manhole & grating covers with frame from approved manufacturers or as directed by the Engineer.

4. MATERIAL

4.1 The metal used for the manufacturer of castings shall be either:-

a). flake graphite iron (also called grey iron) of a quality not less than that specified as grade 10 BS 1452: 1961.

b). Spheroidal or nodular graphite iron or (also called ductile iron) complying with the requirements specified in BS 2789: 1973 for grade 500/7, 600/3 or 700/2, as selected by the manufacturer to suit the design and dimensions of the unit.

4.2 Cast steel gully gratings. The metal used for the manufacture of cast steel gratings shall comply with the requirements for BS 592 grade: A given in BS 3100: 1967.

4.3 Bolts. Bolts supplied for loosely coupling separate sections of covers and grating, shall be steel, hexagon headed, complying with the requirements of BS 4190: 1967 and not less than size M16, complete with hexagon nut: these shall be provided with means to prevent undue tightening of the unit sections. Alternative coupling devices, of used, shall be of steel, have a minimum cross sectional area of 140 mm^2, and be removable and incapable of undue lightening of loosing.

5. Protective Coating

All units shall be supplied coated by dipping, or other equivalent means, using a hot applied coal tar based material. Alternatively, at the option of the manufacturer, a cold applied black bitumen material may be used. No coating shall be applied to any casting unless the surfaces of the casting are clean, dry and free from rust.

6. Design requirements

Products manufactured to the requirements of this standard shall be capable of supporting, without fracture, the following design loads.

Grade of cover or grating	Design load (KN)	(Tonns)
A	350	35.14
B	150	15.06
C	10	1.00

The contractor/manufacturer shall verify the design of each type of unit by submitting a sufficient number of prototypes of the loading tests specified in this clause and in Clause 7 below.

7. Quality Control

7.1 Quality control tests. The contractor/manufacturer shall test sample units, by the method given in appendix A of BS specifications 497, for compliance with the requirements given in 7.2

7.2 Acceptance requirements. Products shall be deemed to comply with the loading test requirements of this standard if, when tested in accordance with the procedures described in section 12, the following requirements are satisfied.

(a) Grey iron units sustain the loads specified in 9.3, 10.3 and 11.3 without fractures.

(b) Ductile iron and cast steel units sustain the loads specified in 9.3, 10.3 and 11.3 without fracture and any resultant permanent set, measured are the midpoint between any two selected supporting seatings after removal of the test load, is not greater than one five hundredth (0.2 %) of the distance between these selected seatings.

7.3 Testing of recessed covers. Recessed covers shall be tested before they are filled with concrete.

8 Marking

All covers, grating and frames shall have clearly cast thereon the number of this British Standard and the appropriate grade, e.g. BS 497, Grade A, and such other markings as may be agreed between the manufacturer and the purchaser.

9 Manhole covers, inspection covers and frames

9.1 Grades, Manhole covers, inspection covers and frames complying with the requirements of this British Standard shall be graded as follows:

Grade A (Extra Heavy duty)
Manhole covers and frames, capable of bearing wheel loads up to 11.50 tones for use in carriage ways. These covers and frames shall incorporate a permanent non-rock design feature such as triangular point suspension or machined faces.

Grade-B

Class-1 (Heavy duty)
Manhole covers and frames, capable of bearing wheel loads up to 5.00 tones, for use in carriage ways carrying relatively slow moving normal commercial vehicles. These covers and frames shall

incorporate a permanent non rock design feature such as triangular point suspension or machined faces.

Grade-B

Class 2 (Medium duty)
Sealed manhole covers and frames (see 9.4.7) capable of bearing wheel loads up to 5.00 tones, for use in area to which vehicles would have only occasional access (e.g. pedestrian precincts).

Grade-C (Light duty)
Sealed inspection covers and frames (see 9.4.7) for use in situation inaccessible to motor vehicle.

The duty, weight, test and working load for 600mm circular or square C.I. cover and frame shall be as follows:-

Class/Duty of Cover and Frame Load	**Gross Weight**	**Peak or Test Load**	**Service Working**
Extra Heavy Weight	275-285Kg	35 Ton	11.5 Ton
Heavy Weight	200-210Kg	15 Ton	5 Ton
Medium Weight	130-140Kg	5 Ton	1.5 Ton
Light Weight	70- 80Kg	1 Ton	upto 1 Ton

9.2 Shape and size. Only minimum clear opening size and certain frame dimensions are stipulated (see 9.5), shape (.e.g square, rectangular, circular) and size being the product of the individual manufacturer's design.

The minimum clear opening dimensions that relate to rectangular designs in table 3,4 and 5 shall be deemed not to be contravened by projections at the corners, required for manufacturing purposes, provided that the resulting reduction of minimum clear opening area does not exceed 15 cm^2 at each of the corners.

9.3 Test loads for quality control purposes (see also Clauses 7 and 12). The loads and sizes of the bearing blocks for the test specified in clause 7 shall be as follows:

Grade of cover	**Test Load**		**Size of block**
	Grey iron (KN)	Ducting iron (KN)	(mm)
Grade-A Manhole covers	350	235	300 dia
Grade B classes 1 and 2 manhole covers	150	100	300 dia
Grade C inspection covers	10	7	300 dia

9.4 Design features

9.4.1 Displacement by traffic. The design of covers shall be such that they cannot be displaced by normal traffic. Grade A and grade B frames of less than 100 mm depth shall be provided with means of

additional anchorage (e.g openings and/or holes for anchor bolts in the flange.

9.4.2 Drainage and skid resistance. Covers of solid top type shall be self draining and have a raised pattern, such as chequers, so as to provide a skid resisting surface.

9.4.3 Loosening. A recess for a prising bar shall be incorporated in manhole covers unless other means of loosening the cover from the frame are provided.

9.4.4 Grade C recessed cover shall be recessed to a clear depth of not less than 28 mm. The recess shall extend, except for keyway housing and locking pads, to within 25 mm of the outside of the frame at surface level.

9.4.5 Keyways. At least two keyways shall be provided in each complete cover, one in each segment for a double triangular cover. Closed keyways shall always be provided on grade B Clase-2 and on grade C covers, open or closed keyways may be provided on grade A, on grade B class 1 and on kerb type gully covers.

9.4.6 Clearance. The maximum clearance between cover section and frame, or between section and section, shall be 3 mm (as for gratings).

9.4.7 Sealing. When a manhole or inspection cover unit is described as sealed, unless an alternative method is agreed by the purchaser, the frame shall provide a continuous means of retaining a sealing material. This standard seal may be of either single or double pattern and the minimum depth of penetration of the cover sealing flange(s) into the frame shall be 10 mm.

9.4.8 Locking. Where specified by the Engineer, means shall be provided for locking sealed covers in their frames, without nullifying the seal. Where locking devices would be rendered ineffective by corrosion, they shall be suitably protected.

9.4.9 Ventilated covers. The total area of ventilation shall be not less than 5% of the minimum clear opening area. The width of slots shall not exceed 40 mm and their length shall not exceed 125 mm.

9.5 Specified dimension and details. The dimensions of manhole covers and frames of specified grades and BS reference numbers shall be as given in table 1 to 5

Table1. Grade-A manhole covers and frames

BS Reference	Minimum clear opening (see 9.2) (mm)	Minimum depth of frame (mm)	Minimum bedding width of frame) (mm)
MA-50	500 dia	75	75
MA-55	550 dia	75	75
MA-60	600 dia	75	75

Table-2 Grade-B class 1 manhole covers and frames

Table 3. Grade-B class 2 single seal manhole covers and frames

BS Reference	Minimum clear opening (see 9.2) (mm)	Minimum depth of frame (mm)	Minimum bedding width of frame) (mm)
MB2-50	500 dia	75	75
MB2-55	550 dia	75	75
MB2-60	600 dia	75	75
MB2-60/45[a]	600 x 450	75	75
MB2-60/60[a]	600 x 600	75	75
MB2R-60/45[b]	600 x 450	75	75
MB2R-60/60[b]	600 x 601	75	75

a. Solid top
b. Recessed top

Table 4 Grade-C single seal inspection covers and frames

BS Reference	Minimum clear opening (see 9.2) (mm)	Minimum depth of frame (mm)	Minimum bedding width of frame) (mm)
MC1-45/45[a]	450 x 450	40	40
MC1-60/45[a]	600 x 450	40	40
MC1-60/60[a]	600 x 600	40	40
MC1R-45/45[b]	450 x 450	60	40
MC1R-60/45[b]	600 x 450	60	40
MC1R-60/60[b]	600 x 600	60	40

a. Solid top
b. Recessed top, See 6.4.5

Table 5 Grade-C double seal inspection covers and frames

BS Reference	Minimum clear opening (see 9.2) (mm)	Minimum depth of frame (mm)	Minimum bedding width of frame) (mm)
MC2-45/45[a]	450 x 450	40	65
MC2-60/45[a]	600 x 450	40	65
MC2-60/60[a]	600 x 600	40	65
MC2R-45/45[b]	450 x 450	60	65
MC2R-60/45[b]	600 x 450	60	65
MC2R-60/60[b]	600 x 600	60	65

a. Solid top
b. Recessed top, See 6.4.5

10 Road gully gratings and frames

10.1 Grades. Road gully gratings and frames complying with the requirements of this British Standard shall be graded as follows.

Grade A

Class 1 Gully gratings and frames, capable for bearing wheel loads up to 11.50 tones, for use in carriageways. These gratings and frames shall incorporate a permanent non rock design feature such as triangular point suspension or machined seating.

Class 2 Gully gratings and frames, incorporating a hinged grating and capable of bearing wheel loads up to 11.50 tones, for use in carriageways.

Grade B Gully gratings and frames, incorporating a hinged grating and capable of bearing wheel loads up to 5.00 tones, for use in carriageways carrying relatively slow moving normal commercial vehicles.

10.2 Shape and size. Two minimum 'nominal' widths, 325 mm and 450 mm, with minimum water way area are specified (see 10.5), shape and size being the product of the individual manufacturer's design (see figure 2* for definition of nominal width). (* for figures, see BS-497 standard)

10.3 Test loads for quality control purposes (see also Clause 7 and 12). the loads and sizes of the bearing blocks for the purposes of the test specified in clause 7 shall be as follows:-

Grade of grating	Test Load			Size of block (see notes 1 and 2)
	Grey iron	Ductile iron	Cast steel	
	KN	KN	KN	(mm)
A	350	235	235	300 x 235
B	100	100	100	300 x 235

NOTE:1 If a non-flat upper surface is specified for a grating (see 7.4.4), the test block shall have a contoured bottom face to mate with the shape of the grating.

NOTE:2 The test block shall be used with the 300 mm side parallel to the kerb face of the gully.

10.4 Design features

10.4.1 Waterway area distribution. Of the total waterway area, there shall be minimum of 45 cm^2 between the kerb face of the frame and a parallel line 50 mm distant (line X-X in figure 2)* and there shall also be a minimum of 60cm^2 between the kerb face of the frame and a parallel line 90 mm distance ((line Y-Y) in figure 2)*.
(* for figures, see BS-497 standard)

10.4.2 Slot width and direction. The maximum width of a slot in a grating shall be limited to 40 mm, this figure to include the 3 mm clearance (see 10.4.3) when this forms an integral part of such a slot. The predominant direction of slots must be at an angle to the kerb face of between 40^o and 90^o .

10.4.3 Clearance. The maximum clearance between grating section and frame, or section and section, shall be 3 mm (see figure 2)*. The area of such clearance shall not count as part of the minimum waterway area specified in

10.5 nor shall it count as part of the areas as specified in 10.4.1, except where such clearance forms an integral part of an adjacent drainage slot.
(* for figures, see BS-497 standard)

10.4.4 Grating surface. The upper surface of all gratings shall be flat unless otherwise agreed between Engineer and manufacturer.

10.4.5 Grating length and width. The actual length of the grating shall not be less than 325 mm.

10.4.6 Displacement by traffic. The design of gratings shall be such that they cannot be displaced by normal traffic. Frames of less than 100 mm depth shall be provided with means of additional anchorage (e.g openings and/or holes for anchor bolts in the flange).

10.4.7 Hinged gratings. When designed to hinge open, gratings shall be self supporting in the fully open position. They shall remain open when the frame is placed on a test slope as indicated below, with the hinge side at the top of the slope.

Type	Test slope
Hinged at kerb	
On road side	1 in 20
Hinged at end	1 in 10

10.5 Specified dimensions and details. The dimensions of roads gully gratings and frames of specified grades and BS reference numbers shall be as give in table 6 to 8.

Table 6 Grade-A class 1 gully gratings and frames

BS Reference	Minimum nominal width (see figure 2)* (mm)	Minimum area of water way Cm^2	Minimum depth of frame (mm)	Minimum bedding width of frame ** (mm)
GA1-325	325	650	75	75
GA1-450	450	900	75	75

** On three sides of grating only, no frame flange on kerb face
* for figures, see BS-497 standard

Table 7 Grade-A class 2 gully gratings and frames

BS Reference	Minimum nominal width (see figure 3)* (mm)	Minimum area of water way Cm^2	Minimum depth of frame (mm)	Minimum bedding width of frame ** (mm)
GA2-325	325	650	75	75
GA2-450	450	900	75	75

** On three sides of grating only no frame flange on kerb face
* for figures, see BS-497 standard

Table 8 Grade-B gully gratings and frames

BS Reference	Minimum nominal width (see figure 3)* (mm)	Minimum area of water way Cm^2	Minimum depth of frame (mm)	Minimum bedding width of frame ** (mm)
GB-325	325	650	75	75
GB-450	450	900	75	75

** On three sides of grating only no frame flange on kerb face

* for figures, see BS-497 standard

11. **Kerb – type gully covers and frames**

11.1 Duty These covers and frames are for use in the kerbs of carriageways.

11.2 Types Units shall provide kerb inlet with access cover opening away from the carriageway. Weir depth (distance from top of cover to top of fixed weir, if any) shall be either 115 mm or 165 mm .

11.3 Test load for quality control (see also clause 7 and 12). A load of 150 kN for grey iron units, or 100 kN for ductile iron units, on a rectangular bearing block 300 mm x 235 mm (with the 300 mm dimension parallel to the kerb face) shall be used for the purpose of the test specified in clause 7.

11.4 Design features

11.4.1 Weir length and water way. The weir length shall be at least 425 mm and a rectangular clearway at least 250 cm^2 in area shall be provided above the weir level (see 11.2), both excluding any debris trap as specified in 11.4.4.

11.4.2 Road retaining bar. Unless otherwise specified by the Engineer, a road retaining bar minimum cross section 35 mm x 25 mm, shall be provided as a standard feature. It shall be supplied loose so as to provide adjustment to suit the required road level. Alternatively, a deflector plate may be provided.

11.4.3 Cover The cover shall be provided with either a keyway(s) for the standard small key or a locking mechanism. Where the cover may be readily raised without the use of the key or other tool, a locking mechanism shall be provided. Where a hinge is provided, this shall be at the rear edge of the cover as viewed from the road. The top shall be self draining and have an adequate raised pattern, such as chequers to provide a slip resisting surface.

11.4.4 Debris trap. A robust grid with horizontal bar(s) or a minimum of two vertical fins shall be provided to act as a debris trap across the open mouth of the unit.

11.4.5 Cleaning access. The opened unit shall provide a minimum rectangular clear opening 400 mm x 250 mm.

11.5 Specified dimensions. The dimensions of kerb-type gully covers and frames of specified BS reference numbers shall b as given in table-9

Table 9 Kerb-type gully gratings and frames

BS Reference	Weir depth (mm)	Minimum net weir length (cm^2)	Minimum rectangular clearway (mm)	Minimum rectangular clear opening (see 10.4.5) (mm)
GK-115	115	425	250	400 x 250
GK-165	165	425	250	400 x 250

12. Loading Test

12.1 Apparatus. The following apparatus is required

12.1.1 A standard frame to be used as a supporting frame.

12.1.2 Bearing block of the shape and size specified in 9.3, 10.3 and 11.3 as appropriate, of hardwood faced with hard rubber or other resilient material, and sufficiently hard to ensure that the load on the cover of grating is only distributed over the full area of the block.

12.1.3 A device, preferable a hydraulic testing machine for applying the load. The device shall be capable of applying a load at least 25% greater than the appropriate load specified in 9.3, 10.3 and 11.3. If a testing machine is used, it shall comply with the accuracy requirements for grade. Grade A or grade B testing machines given in BS 1610: 1964. If any other load measuring device is used it shall be accurate to within 2% of the indicated load.

12.1.4 A measuring device, accurate to 0.1 mm, suitable for indicating deflection measurements on the ductile iron units and cast steel gully gratings.

12.2 Procedure: Carry out the loading test by applying the appropriate load specified on 8.3, 9.3 and 10.3 through the bearing block of specified size specified size placed centrally on the section(s) being tested. For grey iron covers or gratings proceed as described in 12.2.1 for ductile iron covers and grating and cast steel gratings as described in 12.2.2

12.2.1 Grey iron covers of gratings. Support the cover or grating in the frame and, using the testing machine or other load measuring device (12.1.3) apply the appropriate load without shock. Sustain the load for a minimum period of 30 second.

12.2.2 Ductile iron covers and gratings and cast steel gratings. Support the cover or grating in the frame and take two readings with the measuring device (12.1.4) as follows.

a. Before the load is applied, take an initial reading at a point midway between the two selected supporting seatings to establish a datum point. Where it is not practicable to make this measurement exactly on the line drawn between the two supporting seating, it shall be taken on a line parallel to, and as near as possible to, this line.

b. Apply the test load, without shock, five times; sustaining alternating maximum and zero loads for minimum period of 20 seconds then take a second reading at the datum point.

Record the difference between the two readings at the permanent set.

13. Measurement and Payment

13.1 Measurement

Measurement of acceptably completed works of cast iron cover with frame will be made on the basis of actual number of cover with frame provided and installed in position as shown on the drawings or as directed by the Engineer.

13.2 Payment

Payment will be made for acceptably measured quantity of cast iron cover with frame on the basis of actual number quoted in the bill of quantities and shall constitute full compensation for all the works related to the item.

*** End of Section 5230 ***

SECTION - 5240

PUMPING MACHINERY

1.0 SCOPE

The work to be done under this section of the specifications includes furnishing all plant, labour, equipment, appliances and materials and in performing all operations required in connection with the installation of pumping machinery including all accessories as specified herein or shown on the Drawings or as directed by the Engineer.

2.0 MATERIALS AND PRODUCTS

Materials and machinery shall conform to the latest referenced specifications and other provisions specified herein and shall be new and unused. In case where manufacturers are specified, materials and equipment will be of the same manufacturers. In all other cases the Contractor shall submit the names and addresses of the Manufacturers and trade names of the materials and equipment that he intends to buy. Other information such as diagram, drawing and descriptive data will be supplied if so desired by the Engineer. Approval of materials and all the machinery under this provision shall not be construed as authorising any deviations from the specifications. The approval of machinery of manufacturer other than that specified will be purely on the discretion of the Engineer. The Engineer will fully ascertain the facts and satisfy himself as to the performance of the machinery offered by the Contractor.

3.0 SPECIAL REQUIREMENTS OF PUMPS

The Contractor shall furnish with each pump properly identified characteristic curves prepared and certified by the manufacturer showing capacity, head, efficiency and brake horsepower throughout the entire range of the pump.

The pumps shall have stable throttling curves and be suitable for unrestricted parallel operation.

All pumps shall be electric driven.

The pumps and their drives shall not overload or trip when operating against zero pressure.

The design, construction and materials shall be such that damage as a result of cavitation is completely eliminated.

Pumps shall have bearings and be suitable for continuous as well as intermittent operation without external sealing or cooling water. The pumps shall be such that they shall come into operation at once after a prolonged shutdown period without having to take special measures. Pumps shall be capable of delivering specified quantity of water at the specified pressure.

Pumps shall be tested at site before their final acceptance.

Pumps shall be installed at positions shown on the Drawings and/or as directed by the Engineer.

Pumps and their drives shall be in perfect alignment when installed in position.

Pump set shall be provided with reducer/enlarger if necessary on pump discharge pipe and suction pipe.

4.0 FIRE FIGHTING PUMPMING UNIT

The pump set shall be NFPA compliance Skid mounted Fire Fighting pumping unit complete ready to be connected with suction and delivery pipe lines and electric connection, including Horizontal Centrifugal Pumps with class IE3 electric motor of specified capacity or diesel engine drive, head and duty, pressure tank, pressure

switches, sluice & check valves, strainers, suction and discharge headers, pressure gauges, control unit, manual tools, spare parts, testing and commissioning etc., complete in all respect ready to be connected with fire water supply line.

Pump materials shall be as under:

Pump Housing, head & Base	:	Fine grained grey cost iron
Intermediate chamber	:	Stainless Steel
Impeller	:	Stainless Steel
Shaft	:	Stainless steel
Shaft Sleeve	:	stainless steel
Power Transmission	:	Cast Iron split coupling

Pumps shall have mechanical seal. The suction and discharge flanges shall be rated for a working pressure of 25bars for fire pumps. The flanges shall be drilled to BS 10 (Table 'D' or 'E') or BS 4504.
Motors shall be of efficiency class IE3 and run on 3-phase, 400 volts + 10% 50 c/s A/C power motors.

5.0 POTABLE WATER PUMP

The pump shall be close coupled, horizontal, centrifugal pump of specified capacity, head and duty, totally enclosed, fan cooled, squirrel cage induction motors of specified power.

Pump material shall be as under:

Body	: Fine grained grey cast iron
Impeller	: Bronze
Shaft	: Bronze or stainless steel

Pumps shall have mechanical seal. The suction and discharge flanges shall be rated for a working pressure of 10 kg/cm2 for potable water pumps. The flanges shall be drilled to BS 19 (Table 'D' or 'E') or BS 4504.

Motors shall run on 3-phase, 400 volts + 10%, 50 c/s A/C power motors shall be protected from low voltage, overload, overheating and phase failure.

Potable water pumps and motors shall be installed on concrete foundation with anchor bolts.

Potable water pumps will be automatically operated at pre-set levels in overhead tanks with help of level switches installed in respective overhead water tanks. In case a pump fails to start automatically, an alarm will be automatically sounded at preset minimum water level in overhead water tank.

OPERATION OF PUMPS:

- Both pumps are duty pumps.
- Duty of pumps shall be interchangeable.
- Pumps shall start and stop at predetermined low and high water level respectively, through level switches installed in overhead water tank.
- A duty cycle relay shall be installed for alternate operation.
- Alarm shall sound at highest water level in overhead water tank to describe that pumps has not stopped.
- Dry running relay in UGWT should also be installed.

6.0 SUBMERSIBLE DRAINAGE PUMP

The pump shall consist of submersible drainage pump and motor with duckfoot

bend/auto coupling, guide rails and chain etc of the specified capacity and head and shall be integral sealed unit with strainer.
Pump material shall be as under:

Casting:	Cast Iron
Impeller / Bowl:	Cast Iron
Shaft:	Stainless steel
Bearing:	Pre-lubricated bearing
Motor:	Air filled water tight

The pumps shall be installed inside the pit as shown on drawing. The discharge flange shall be threaded to BS 21 and shall be rated for working pressure of 10 kg/cm^2.

6.1 INSTALLATION

The submersible drainage pumps shall be installed in the sump pits at the locations shown on the drawings.

6.2 PUMP ACCESSORIES

Pumps shall be provided inclusive of the following accessories:

i. Duck foot Bend, Guide rails and pulling chain etc.
ii. Pressure gauge, level switches, flow switches etc.
iii. Reducer/enlarger is necessary if the pump discharge size is different from discharge piping.

6.3 MOTOR PROTECTION

Motors of 3kw or less power shall be started direct on line. Larger motors shall be started by star-delta starter.

Motor shall be protected against under voltage over voltage, overload, over-heating and phase failure.

Motor shall be rated for normal operation against a voltage fluctuation of + 10% and frequency fluctuation of + 2Hz.

6.4 CONTROL

Operation of pumps shall be controlled by level switches installed inside the sump pit.

i. One pump shall be duty and one shall be standby.
ii. Pumps shall start and stop at the designated water levels inside the sump.
iii. If duty pump fail to start, the standby pump shall automatically come into operation.
iv. If standby pump fails to start, an alarm shall be sounded at high water level.

6.5 LEVEL SWITCH

Level switches shall be electric actuating device, which will close/open the circuit at preset lower/higher pressures. The device shall be housed in diecast aluminium casing with enamel finish. The switch shall be adjustable. The pressure switch shall be rated for a working pressure of 16 Bar. The switch shall be wired to control panel.

6.6 WATER LEVEL INDICATOR

The water level indicator for high and low water level cut off shall operate on 230 Volt AC, 50 Hz and supplied complete with float, float chains, counter-weights, chain clamps, steel mounting brackets, chain guide roller and any other equipment and material necessary for installation and satisfactory operation.

The level indicator shall have at least 5 switch-contacts or as required for sensing the required water levels within the specified range. The level indicator shall be suitable to match with the specific gravity of the fluid in which it is intended to be installed. All operational, constructional and installation details shall be furnished by Contractor for approval.

The Contractor may quote for non-mechanical type of water level indicator to give equivalent performance. Technical literature and data of the indicator is to be furnished along with the bid documents.

7 MAINTENANCE MANUALS AND TOOLS

7.1 A book or books containing the complete information in connection with the assembly, operation, lubrication, adjustment and repair of the pumping equipment, electric motor, together with detailed parts list with drawings or photographs shall be furnished in duplicate.

7.2 For the pump room, special tools necessary for maintenance and repair of the pumps and electric motors including tools kits, grease guns etc. with accessories shall be furnished.

7.3 The manufacturer's recommended list of spare parts to be stocked by the CLIENT shall be submitted by the Contractor to the Engineer for approval. Such spare parts will also be furnished by the Contractor.

7.4 All the maintenance manuals, tools, spare parts etc., shall be supplied by the Contractor at no cost of the CLIENT and all cost shall be deemed to be included by the Contractor in his bid against item of pumping set.

8 MEASUREMENT AND PAYMENT

8.1 Pumping Machinery

8.1.1 **Measurement**

Measurement for payment of pumping machinery pressure gauge, brass strainer, pressure switch and water level indicator shall be the actual number acceptably provided and installed in position; the Contractor's bid against these item shall include cost of providing and installing the pumping machinery including the pumps, electric motors, all accessories, manuals, tools, spare parts, etc., as shown on the Drawings, as specified herein or as directed by the Engineer.

8.1.2 **Payment**

Payment will be made for acceptable measured quantity of pumping machinery pressure gauge, brass strainer, pressure switch and water level indicator on the basis of unit rate per number quoted in the Bill of Quantities. The amount bid shall be full payment for the work specified.

*** End of Section 5240 ***