



# UNITED NATIONS HIGH COMMISSIONER FOR REFUGEES (UNHCR)

## CONSTRUCTION OF CCU BLOCK AT DISTRICT HEADQUARTER HOSPITAL, BANNU

---

# TECHNICAL SPECIFICATIONS

---

NOVEMBER, 2022



National Engineering Services Pakistan (Pvt) Limited  
NESPAC House Sector G-5/2, Islamabad, Pakistan  
Phone: +92-51-9221910 - 13 Fax: +92-51-9221914  
Email: [Islamabad@nepak.com.pk](mailto:Islamabad@nepak.com.pk)  
<http://www.nepak.com.pk>

Clearance Code	4199/321/M/194(22)	Doc No.	4199-02	Rev No.	00
----------------	--------------------	---------	---------	---------	----

# **CIVIL WORKS**

## **SECTION - 2300**

### **PLAIN AND REINFORCED CONCRETE**

- 1. SCOPE**
- 2. APPLICABLE CODES AND STANDARDS**
- 3. SUBMITTALS**
- 4. MATERIALS**
- 5. MATERIAL TESTING**
- 6. EXECUTION**
- 7. FINISHING OF FORMED SURFACES**
- 8. REPAIR OF DEFECTS**
- 9. CONCRETE CONSTRUCTION TOLERANCES**
- 10. ACCEPTANCE OF STRUCTURE**
- 11. MEASUREMENT & PAYMENT**

## **SECTION - 2300**

### **PLAIN AND REINFORCED CONCRETE**

#### **1.0 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, manufacture, transporting, placing, consolidating, finishing and curing of plain and reinforced concrete for pavements and other structures as shown in the drawings, as specified herein and as required by the site conditions or as directed by the Engineer, for a complete job. Reinforcement does not form part of this section.

#### **2.0 APPLICABLE CODES AND STANDARDS**

The latest edition of following ACI, ASTM, Pakistan & British Standard are relevant to these specification wherever applicable:

##### **2.1 ACI (American Concrete Institute)**

- 117 Standard Specification for tolerances for concrete construction and materials.
- 201.2 Guide to durable concrete
- 211.1 Recommended Practice for Selecting Proportions for Normal and Heavy Weight Concrete.
- 214 Recommended Practice for Evaluation of Strength Test Results of Concrete.
- 301 Specifications for Structural Concrete for Buildings
- 304 Recommended Practice for Measuring, Mixing, Trans-ported, and Placing Concrete
- 305 Hot Weather Concreting
- 308 Recommended Practice for Curing Concrete
- 309 Recommended Practice for Consolidation of Concrete
- 315 Manual of Standard Practice for Detailing Reinforced Concrete Structures
- 318 Building Code Requirements for Reinforced Concrete
- 347 Recommended Practice for Concrete Formwork
- 350R Concrete Sanitary Engineering Structures
- 544.1R State-of-the-Art Report on Fiber Reinforced Concrete
- 544.2R Measurement of Properties of Fiber Reinforced Concrete
- SP-2 Manual of Concrete Inspection
- SP-142 Fiber Reinforced Concrete Developments and Innovation
- SP-155 Testing of Fiber Reinforced Concrete
- SP-182 Structural Applications of Fiber Reinforced Concrete

UBC Uniform Building Code

COE CRD 48-92 Method of Test for Water Permeability of Concrete; U.S Army Corps of Engineers

NACE National Association of Corrosion Engineering

- A199.1 Construction and Industrial Plywood

2.2 ASTM (American Society for Testing and Materials)

- A 185 Standard Specification for Welded Steel Wire, Fabric for Concrete Reinforcement
- A 305 Minimum Requirements for the Deformations of Deformed Steel bars for Concrete Reinforcement
- A 499 Hot-Rolled Rail Carbon Steel Bars and Shapes
- A 615 Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
- A 616 Standard Specification for Rail-Steel Deformed and Plain Bars for Concrete Reinforcement
- A 617 Standard Specification for Axle Steel Deformed and Plain Bars for Concrete Reinforcement
- A 675 Steel Bars and Bar Size Shapes, Carbon, Hot-Rolled, Special Quality, Subject to Mechanical Property Requirements
- A 615 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
- A706 Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
- A767 Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
- A775 Epoxy-Coated Reinforcing Steel Bars
- C 31 Making and Curing Concrete Test Specimens in the Field
- C 33 Concrete Aggregates
- C 39 Compressive Strength of Cylindrical Concrete Specimens
- C 40 Organic impurities in sand for concrete.
- C 42 Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
- C 78 Flexural Strength of Concrete (Using Simple Beam with Third Point Loading)
- C 87 Effect of organic impurities in fine aggregates on strength of mortar.
- C 88 Soundness of Aggregates
- C 94 Ready-Mixed Concrete
- C 109 Compressive Strength of Hydraulic Cement Mortars
- C 117 Materials Finer than No.200 Sieve in Mineral Aggregates by washing.
- C 123 Light weight pieces in aggregates

- C 125 Concrete and Concrete Aggregates
- C 127 Test method for Specific Gravity and Absorption of Coarse Aggregate
- C 128 Test method for Specific Gravity and Absorption of Fine Aggregate
- C 131 Resistance to Degradation of small size Aggregate by Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine
- C 136 Sieve or Screen Analysis of Fine and Coarse Aggregates
- C 138 Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
- 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 Test Method for Water Retention of Concrete Curing Materials
- C 157 Length Change of Hardened Hydraulic Cement Mortar or Concrete
- C 171 Sheet Materials for Curing Concrete
- C 172 Method of Sampling Fresh Mixed Concrete
- C 173 Air Content of Freshly Mixed Concrete by the Volumetric Method
- C 185 Air Content of Hydraulic Cement Mortar
- C 186 Heat of Hydration of Hydraulic Cement
- C 188 Density of Hydraulic Cement
- C 191 Time of Setting of Hydraulic Cement by Vicat Needle
- C 217 Weather resistance of Natural State
- C 227 Potential Alkali Reactivity of cement - Aggregate Combination.
- C 231 Air Content of Freshly Mixed Concrete by the Pressure Method
- C 260 Air-Entraining Admixtures for Concrete
- C 289 Potential reactivity of Aggregate
- C 293 Standard test method for Flexural Strength of Concrete (using simple beam with center Point Loading)
- C 309 Liquid Membrane-Forming Compounds for Curing Concrete
- C 321 Standard Test method for Bond Strength of Chemical Resistant material
- C 330 Light Aggregates for Structural Concrete
- C 332 Light weight aggregates for insulating concrete.
- C 348 Standard Test method for Flexural strength of Hydraulic Cement Mortars

- C 400 Requirements for water use in mixing and curing concrete
- C 494 Chemical Admixtures for Concrete
- C 535 Resistance to Abrasion of Large Size Coarse Aggregates
- C 595 Specification for Blended Hydraulic Cements
- C 596 Standard Test method for Drying, shrinkage of Mortar Containing Hydraulic Cement
- C 685 Concrete Made by Volumetric Batching and Continuous Mixing
- C 881 Epoxy-Resin-Base Bonding Systems for Concrete
- C 989 Ground Granulated Blast – Furnace Slag for use in Concrete
- C 995 Standard Test Method for Time of Flow of Fiber Reinforced Concrete Through Inverted Slump Cone
- C 1018 Standard Test Method for Flexural Toughness and First- Crack Strength of Fiber-Reinforced Concrete (Using Beam with Third-Point Loading)
- C1116 Standard specification for Fiber-Reinforced Concrete and Shotcrete)
- C 1399 Test Method for Obtaining Average Residual-Strength of Fiber-Reinforced Concrete
- D 75 Sampling Aggregates
- D 512 Chloride Ion in Water and Waste Water
- D 516 Sulphate Ion in Water and Waste Water
- D 596 Reporting Results of Analysis of Water
- D 1190 Concrete Joint Sealer, Hot-Poured Elastic Type
- D 1411 Water-Soluble Chlorides Present as Admixes in Graded Aggregate Road Mixes
- D 1751 Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
- D 1752 Preformed sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Concrete
- D 1850 Concrete joint sealer (cold application type)
- E 11 Wire-Cloth Sieves for Testing Purposes
- E 96 Water Vapour Transmission of Materials in Sheet Form
- E 154 Materials for Use as Vapour Barriers under Concrete Slab
- E 337 Relative Humidity by Wet and Dry Bulk Psychrometer
- CALIF 217 Method of Test for Sand Equivalent
- CALIF 227 Method of Test for Evaluating Cleanness of Coarse Aggregate

- CE CRD C 119 Method of Test for Flat and Elongated Particles in Coarse Aggregate
- CE CRD C400 Requirements for Water for Use in Mixing and Curing Concrete
- CE CRD C 513 Rubber Waterstops
- CE CRD C 572 Polyvinyl Chloride Waterstops
- CE CRD C 588 Expansive Grout
- FF MM G 650 Epoxy-Resin Grout

### 2.3 B.S (British Standard)

- 12 Portland cement (Ordinary & Rapid Hardening)
- 146 Portland Blast Furnace Slag Cement
- 410 Test Sieves
- 693 General Requirements for Oxy-acetylene Weld-ing
- 812 Methods for the sampling and testing of mineral aggregates, san fillers.
- 882 Coarse and fine aggregates from natural sources.
- 1305 Batch Mixer.
- 1881 Methods of Testing Concrete
- 3148 Tests for water for making concrete.
- 4027 Sulphate Resisting Portland Cement
- 4449 Carbon Steel Bars for the Reinforcement
- 4483 Steel fabric for the reinforcement of concrete
- 8110 Structural use of concrete.

In addition, the latest editions of other Pakistan Standard, ACI, ASTM & British Standard and other Standards as may be specified by the Engineer for Special Materials and construction are also relevant.

### 3.0 SUBMITTALS

All submittals shall be in accordance with the schedule of submittals prepared by the Contractor and approved by the Engineer.

### 3.1 Proposed Mix Designs

Submit proposed designs for trial design batches for each grade of concrete along with samples of proposed material.

Submit proposed final mix designs for each grade of concrete at least 7 calendar days before the date planned for the start of concrete placement, along with samples of proposed materials which differ from those submitted previously, and reports of successful 3, 7 and 28 calendar day strength tests, for Engineer's approval.



### 3.2 **Construction Procedure**

Submit to the Engineer procedures for the following:

- a) Both hot and cold weather concreting procedures shall be submitted to the Engineer by Contractor regardless of the need for the immediate implementation of such not less than two weeks before beginning the work. Procedures shall include requirements for insulation, enclosures and the like. Finishing procedures and timing and duration of curing shall be described.
- b) Contractor's construction procedures shall be computer word processed procedure and shall include charts and diagrams as applicable and necessary, to fully explain the subject procedures, methods and equipment operation in order to allow effective review by the Engineer, assist the Testing Agency's evaluation of the work, and to allow Contractor's personnel to perform work in full conformance to the Tender & Contract Document.
- c) Protection of concrete against injury due to mechanical contact and construction operation.
- d) Protection of work by other trades.

### 3.3 **Placement Schedule**

Submit a placement schedule for approval prior to start of concrete placement operations. Daily concrete pour schedules shall be submitted 24 hours in advance of planned pours.

### 3.4 **Formwork**

Submit for approval copies of manufacturer's data and installation instructions for proprietary materials including form coatings, manufactured form systems, ties and accessories.

### 3.5 **Certificates of Compliance**

Submit certificates of compliance covering cement types, reinforcement, grout materials, additives, epoxy-resin materials etc. The certificates of compliance shall include the material or product manufacturer's statements that supplied items conform to Specifications.

### 3.6 **Testing Programme**

Submit test programme for all specified requirements alongwith the testing schedule for approval of the Engineer.

### 3.7 **Test Reports**

Submit test reports showing the result of required tests and compliance with specified standards and codes, for approval. Test reports shall be certified by the Contractor and the Testing Agency.

### 3.8 **Samples**

Submit to the Engineer for acceptance prior to purchase, fabrication or delivery, samples of materials for his approval.

Substitute products materials or fixtures proposed by the Contractor shall be submitted as samples for approval. The samples shall be accompanied by detailed information about materials.

### 3.9 Shop Drawings

- a) Shop drawings shall be submitted to the Engineer for approval in accordance with the requirements of the Contract Documents and as specified herein under:
- b) Shop drawings furnished for this section shall conform to the best standards of the construction industry. Shop drawings shall be prepared 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. As evidence of conformance with this requirement, each shop drawing shall bear the seal and the self-written signature of Contractor's registered Professional Engineer.
- c) Shop drawings shall include plans, elevations, sections and complete details to describe clearly, at an ample scale for all works to be provided. Drawings shall be accurately dimensioned, where applicable, and shall be noted clearly.
- d) Work of Other Trades: Show in the shop drawings, and dimension thereon, holes required for passage of work of other sections through Cast-In-Place Concrete Work. Prepare and submit to the Engineer field work drawings for holes not shown in shop drawings.
- e) Submit shop drawings for curved and radial concrete formwork and identify the formwork materials proposed for use.
- f) Construction Joint, Expansion Joint and contraction Joint Drawings: Show all joints given in the drawings, specified herein, and required by Contractor to provide for the sequence of pourings. Submit in sufficient time to allow the orderly detailing of reinforcing steel. Reinforcement shop drawings shall be prepared in conformance with the accepted Construction Joint, Expansion Joint and contraction Joint Drawings. Measures to control cracks e.g. shrinkage strips, admixture as per relevant ACI codes shall be shown on the drawings.
- g) Reinforcing Steel, including welded wire fabric (WWF), shall be detailed in strict accordance with the methods and procedures provided in "ACI Detailing Manual". Reinforcing steel drawings shall be submitted simultaneously with related shop drawings.

Prepare shop drawings which provide for reinforcement, including dowels, properly positioned in all concrete work, so that material can be properly cut, bent and placed. Form not be removed for at least twelve (12) hours after the concrete has been placed. Forms shall be carefully given in shop drawings. Reinforcing steel drawings shall show, to scale, all concrete work including pits, kerbs, trenches, pads, equipment bases, steps, slopes, radii, curves, openings, holes, blockouts and the like. Provide schedules and details showing placing sequences, bending, lengths and locations of all reinforcement.

- h) Detailing: All reinforcing steel shall be detailed in strict compliance with ACI 318 and ACI 315.

### 3.10 Coordination Drawings

Submit coordinated drawings of the following:

All sleeve locations, whether round or of other shape, penetrating exterior and interior walls, pits, slabs, beams, other structural systems and pavements.

The position of all embedded items required to receive the work of other trade, including details needed to assure correct placement of both the embedded items and the reinforcing steel.

The Contractor shall coordinate and crosscheck for accuracy, completeness and correct relationship to the work of other sections, each shop drawing prepared for the work of this section, including each shop drawing prepared by nominated subcontractors. Contractor's check shall include a verification of strict compliance with the Contract Documents and shall be performed prior to submission of each shop drawing for review by the Engineer. The Contractor shall certify the co-ordination, accuracy, and Contract compliance of each shop drawing by a written statement placed in each drawing and attested by the responsible person in charge of the work for Contractor. The personally inscribed initials of the person(s) preparing each drawing as well as the detailing agency's supervisor and chief checker shall be included in the title block or similar prominent location.

### **3.11 Mill Test**

Furnish the Engineer with certified mill test report for cement and for steel reinforcement, including bars, welded wire fabric, dowels, anchors and splices for approval.

### **3.12 Name of Manufacturers/Suppliers**

Submit for acceptance by the Engineer:

- Aggregates
- Ready mix concrete
- Reinforcing bars
- Welded steel wire fabric
- Concrete accessories
- Cement
- Admixture
- Joint filler
- Joint sealants
- Water stops
- Membrane curing, sealing, hardening compound
- Bonding compound
- Form oil
- Anchors

## **4.0 MATERIALS**

### **4.1 Cement**

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

- Sulphate Resistant Portland Cement ( low alkali) complying with the requirements of BS-4027 or ASTM C-150 Type V.
- Ordinary Portland Cement Type II (low alkali) complying with the requirements of BS-12 or ASTM C-150.
- Portland Blast-Furnace Slag Cement shall conform to BS-146 or to ASTM C-595. Slag shall consist of finely ground granulated iron blast-furnace slag and shall conform to ASTM C-989 Grade 80, 100, or 120.
- The proportioning of OPC and Portland Blast Furnace Slag material shall be in the ratio of 60 OPC to 40 Slag or as approved by the Engineer."

4.1.2 Unless otherwise specified, ordinary Portland Cement complying with the requirements of BS12 shall be used.

- 4.1.3 The Contractor shall supply to the Engineer at fortnightly intervals, reports of tests for conformance with the relevant specified 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.
- 4.1.4 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.
- 4.1.5 There shall be sufficient cement at site to ensure that each section of work is completed without interruption.
- 4.1.6 Cement reclaimed from cleaning of bags or from leaky containers shall not be used.
- 4.1.7 The Contractor shall provide and erect (at his cost) in a suitable plain, dry, well ventilated, weather-proof and water proof shed of sufficient capacity to store the cement.
- 4.1.8 The cement shall be used as soon as possible after delivery and cement which the Engineer consider 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.
- 4.1.9 Mixing together of different types of cement shall not be permitted.

#### **4.2 Aggregates**

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

Aggregates shall conform with ASTM C33 (including applicable ASTM Documents referenced therein) and as specified. Coarse aggregates shall be well graded from fine to coarse within the prescribed limits of this specification. Fine aggregate shall consist of natural sand, manufactured sand or combination of the two and shall be composed of clean, hard, and durable spherical or cubical particles. Coarse aggregate shall consist of crushed or uncrushed gravel, crushed stone, or a combination thereof and shall be clean, hard, uncoated particles of maximum nominal size as specified for each grade of concrete.

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. The materials shall be stock piled for a period before use for at least a day so as to drain nearly to constant moisture content. The grading of the coarse and fine aggregates shall be tested at least once for every 100tons supplied, to ensure that grading is uniform and same as that of the samples used in preliminary tests.

The sulphate content of aggregates shall not exceed 0.40 percent by weight for each individual source of coarse and fine aggregate. The chloride content of aggregates shall not exceed 0.05 percent by weight for each source of coarse and fine aggregate. The total sulphate content of concrete shall not exceed 4.0 percent by weight of the cement. The total chloride content of concrete shall not exceed 0.40 percent by weight of the cement.

Aggregates, when tested in accordance with CRD C119 shall contain not more than 8 percent by weight of thin, flat and elongated particles.

Petrographic analysis of aggregate shall be carried out initially for each source and periodically whenever directed by the Engineer.

The specific gravities and absorption of aggregates shall be identified in accordance with ASTM C 127 and ASTM C 128.

Prior to the initial use of each source of aggregates, certified tests shall be performed on aggregates to verify compliance with these specifications and submitted for Engineer's review and approval.

Gradation of coarse aggregates for concrete shall conform to the gradations given in Table-I.

The gradation of combined coarse and fine aggregates shall be within the grading limit specified in Table-II.

The Fineness Modulus of fine aggregate (sand) shall be not less than 2.6 nor more than 3.1. In at least four out of five successive test samples, the modulus shall vary by not more than 0.20 from the moving average for the last five tests. The gradation of the coarse aggregate will be suitable if the results of four out of the last five consecutive tests comply with the gradation requirements.

Furnish certified test reports for aggregate tests listed in Table-III, Quality Tests.

#### **4.3 Water**

Only clean water from the 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. Water analysis shall be performed in accordance with ASTM D596.

#### **4.4 Concrete Patching Compound**

Use an approved epoxy-resin compound applied according to manufacturer's instructions. Compound shall be paintable material which produces no evidence of bleeding and which, after final set, shall not be affected by high humidity and moisture. Epoxy-resin compound shall comply with FSMM-G-650, Type 1, Grade C.

#### **4.5 Fibre Reinforced Concrete**

Duracrete Polypropylene Fiber or equivalent concrete reinforcing: Concrete shall be treated with Duracrete polypropylene synthetic reinforcing fibers or equivalent when indicated on the drawings or as otherwise specified by the Architect/Consultant in accordance with the fiber manufacturer's recommendations.

- a. Synthetic reinforcing fibers shall be manufactured from virgin polypropylene.
- b. The dosage rate shall be 1.8 kg/cu.m (3.0 Lb/ Cu yd) of concrete.
- c. Fiber supplier shall provide technical assistance, if required.
- d. All fibers must meet or exceed the standards and specifications set forth in ACI 544, Fiber Reinforced Concrete.
- e. Listed below are the minimum properties of the polypropylene fibers for use. All fibers must meet or exceed the characteristics described in ACI-544, IR, table 1.1, Fiber Reinforced Concrete.
  1. Tensile Strength: 4.4 grams/denier
  2. Elongation at break: 12%
  3. Fiber: 100% Fibrillated / Monofilament Polypropylene (as per site requirement)
  4. Lengths: 19 mm
  5. Absorption: Nil
  6. Specific gravity: 0.9
  7. Ignition point: 593 °C
  8. Melting point: 160-170 °C

9. Heat & UV stabilization: Long term
10. Thermal conductivity: Low
11. Electrical conductivity: Low
12. Salt resistance: High
13. Acid resistance: High
14. Alkali resistance: 100% (alkali proof)

#### 4.6 **Additives**

All additives 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.

Liquid Crystalline Water Proofing Bitocrete C-16 for Schomberg Germany or equivalent.

#### 4.7 **Vapour Barrier**

Polyethylene sheeting conforming with ASTM E154 and 0.2mm thick as a minimum. Other similar material having a vapour permeance rating not exceeding 0.5per meter as determined by ASTM E96, will be considered unless noted otherwise.

#### 4.8 **Grout**

- a) Damp Pack Bedding Grout: Mix of one part portland cement and 2« parts of fine aggregate proportioned by weight and not more than 4« gal. (17 liters) of water per bag of cement.
- b) Pre-mixed, Non-Shrink, Non-Metallic Grout: "Masterflow 713" manufactured by Master Builders, "Euco-N.S." manufactured by the Euclid Chemical Company or other approved equal.
- c) Pre-mixed, Non-Shrink, Metallic Grout: "Embeco636" manufactured by Master Builders, "Firmix" manufactured by the Euclid Chemical Co., or other approved product.
- d) Expansive Grout: CE CRD-C588, Type A or M, as required.

#### 4.9 **Cover Material for Curing**

Curing material shall conform to the following:

- a) Impervious Sheeting: ASTM C171, type optional, except that polyethylene sheeting shall be 0.1mm minimum thickness, white opaque. Where the work is exposed to high winds the impervious sheeting shall not be used.
- b) Burlap: Cloth made of jute or kenaf shall conform with AASHTO M182 and shall weigh a minimum 0.3kg/m<sup>2</sup>.
- c) Liquid Membrane Forming Compound: ASTM C309, Type 2.

#### 4.10 **Joint Fillers**

ASTM D 1751, preformed, resilient bituminous type or ASTM D1752, preformed sponge rubber.

#### 4.11 **Joint Sealants**

ASTM D 1190, ASTM D 3569, ASTM D 3406, hot-pour type.

#### 4.12 **Waterstops**

Provide flat, dumbbell type or center bulb type water stops at construction joints where shown. Web thickness not less than 6mm (1/4 in.) for units up to 125mm (5 in.) wide, and not less than 10mm (3/8 in.) for widths over 125mm (5 in.). Provide polyvinyl chloride (PVC) waterstops of approved manufacturer.

#### 4.13 **Epoxy Resin**

ASTM C 881, type, Grade 3, Class C.

#### 4.14 **Formwork**

##### a) **Formwork for Concrete Pavement**

Forms 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 metres (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 3 millimeter in 3 metres (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.

##### b) **Formwork for Structures**

Material, workmanship etc. of formwork for structures, refer specification Section 2100.

#### 4.15 **Reinforcement**

Materials for reinforcing steel, welded wire fabric, dowels and tie bars, refer specification Section 2200.

## 5.0 MATERIAL TESTING

### A. Samples and Testing

Samples from stock on the site or suppliers materials shall be taken by the Contractor in presence of the Engineer. Furnish tests and certificates as specified.

### B. Cement

Sampled cement shall be tested by a testing laboratory. Certified copies of laboratory test reports shall be furnished for each lot of cement and shall include all test data, results and certification that the sampling and testing procedures are in conformance with the Specifications for approval. No cement shall be used until test results are satisfactory. Cement that has been stored for more than four months after being tested shall be re-tested before use. Cement found unsatisfactory under test shall be immediately removed from the construction site or supplier stock.

### C. Aggregates

Aggregate sampling shall conform to ASTM D 75. Aggregates shall be sampled and tested by a testing laboratory. No aggregate shall be used until test results are satisfactory to the Engineer.

### D. Water

Water analysis shall be performed in accordance with ASTM D 596, and the report shall be submitted for Engineer's approval.

### E. Admixtures

Sampling and testing of all admixtures used in concrete mix shall be in accordance with the standard procedure recommended by an approved testing laboratory. No admixture shall be used until test results are satisfactory and approval.

### F. Concrete

- a) **Compressive Strength:** The Contractor shall provide and test three sets of specimens taken under the supervision of the Engineer from each 125 cubic metres (4,500 Cft.) or not less than once a day each grade of concrete placed. Samples shall be secured in accordance with ASTM C 172. Test specimens shall be made and cured in accordance with ASTM C 31. Specimens shall be tested in accordance with ASTM C 39 or ACI 214. Test specimens shall be evaluated for each grade of concrete specified in conformance with ACI 318, chapter "Concrete Quality". The standard age of concrete for tests shall be 3, 7 and 28 calendar days.
- b) **Slump and Entrained Air:** Slump test and entrained air tests shall be performed in the field under the supervision of the Engineer. Slump test shall conform to ASTM C 143 and entrained air content shall be determined in accordance with ASTM C 231 or C 173 as applicable.
- c) **Concrete removed for the Structure :** When the results of the strength test of the specimen indicate deficiency in specified requirements or where there is other evidence that the quality of concrete is below specified requirements, core boring tests shall be made in conformance with ASTM C-42. If a deficiency is discovered, the Contractor may be allowed to make load test, at his expense, and results shall be evaluated in conformance with ACI 318, Chapter 20.



## 5.1 Frequency of Testing

- a) The following tests shall be performed initially for approval and as per required frequency thereafter:

-	Aggregates	ASTM C 33	-----
-	Soundness	ASTM C 88	bi-weekly
-	Specific Gravity	ASTM C 127	weekly
-	Absorption	ASTM C 128	weekly
-	Abrasion	ASTM C 131	weekly
-	Gradation	ASTM C 136	daily
-	Sand Equivalent	ASTM C 217	weekly
-	Cleanliness	ASTM C 227	weekly
-	Elongation	CRD C 119	bi-weekly
-	Chloride Ion	ASTM D 512	bi-weekly
-	Water Analysis	ASTM D 596	bi-weekly

- b) The following tests shall be performed initially for approval and thereafter as specified:

- Concrete Compressive Strength: ASTM C39. Three sets of specimens for each **75 cu.m (2,625 Cft.)** of each grade of concrete placed or at least three sets for each grade per work shift.
- Concrete Sulphate (S03), Chloride Content **and pH value**:  
One test **per month** for each grade of concrete. Broken laboratory specimens from strength tests shall be used for hardened concrete Sulphate, Chloride content and **pH Value** tests."

## 6.0 EXECUTION

### 6.1 Nominal Concrete Mixes

- 6.1.1 The cement, fine aggregate and the coarse aggregate shall be weighed separately. The proportions of cement to fine aggregate and coarse aggregate shall be adjusted as per ACI 211 & ACI 318 so as to provide the concrete of the required crushing strength when tested as set out in Table1.

- 6.1.2 The Contractor shall regulate and arrange mixing of the ingredients for the designed mix of the concrete by weight-batching.

#### 6.1.3 Water/Cement Ratio

The quantity of water used shall be just sufficient to produce a dense concrete of the specified strength. For all exterior exposed work and foundations the water/cement ratio shall not exceed 0.45, allowance being made for any water in the fine and coarse aggregates.

#### 6.1.4 Workability

Admixtures may be used where necessary to achieve required workability, with the Engineer's approval. For concrete pavements, the mix determined shall be workable concrete having a slump between 13mm (1/2 in.) and 50mm (2 in.), as determined by ASTM C143. For other structures the concrete shall be proportioned and produced to have a slump of 75mm (3 in.) or less if consolidation is to be by vibration, and 125mm (5 in.) or less if consolidation is to be by methods other than vibration.

## 6.2 Strength and Durability Requirements for Concrete

Strength and Durability Requirements for Concrete are given below:

Class of Concrete	Specified Cylinder Compressive Strength at 28 days MPa / psi
A1	35.0 / 5,000
A	28.0 / 4,000
B	21.0 / 3,000
C	17.0 / 2,465
D	8.0 / 1,160
E	5.0 / 725

6.2.1 The Contractor shall adopt all necessary measures as per ACI201.2, like proper grading of aggregates, control of water cement ratio and cement content, proper compaction and curing, to achieve dense and durable concrete.

6.2.2 The Contractor shall submit mix design by weight for each grade of concrete at least 45 calendar days before any placement of concrete, alongwith samples of the proposed materials. Manufacture 12nos. test cylinders 12" (305mm)x6"(152mm) in accordance with ASTM C-31, and in accordance with the mix design batching by weight and test 3 cylinders each at 3, and 28 days in the presence of Engineer's Representative, in accordance with ASTM C-39 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.

## 6.3 Batching, Mixing and Delivery

a) Batching: The Contractor shall submit to the Engineer for review the plans and capacity of the concrete batching plant and delivery equipment, which shall comply with ASTM C-94.

The Contractor shall furnish test certificates for the scales and metering devices before producing concrete and at least every six weeks thereafter.

b) Accuracy of Plant Batching: Cement measured by weight in individual batchers shall be within  $\pm 1.0$  percent of the desired intermediate and final weights in cumulative batchers. The minimum batching accuracy shall be  $\pm 0.3$  percent of scale capacity for small loads below 30 percent of scale capacity.

Aggregate measured by weight in individual batchers shall be within  $\pm 2.0$  percent of the desired weight, or within  $\pm 1.0$  percent of the desired intermediate and final weights in cumulative batchers; but in either case, the minimum batching accuracy shall be  $\pm 0.3$  percent of scale capacity for small loads below 15 percent and 30 percent of scale capacity, respectively.

Water measured by volume or by weight shall be within  $\pm 1.0$  percent of the desired amount.

Liquid admixtures measured by volume or by weight shall be within  $\pm 1.0$  percent of the desired amount.

Compensation for changes of moisture content in fine and coarse aggregate shall be made by devices which shall correct the batch water and the weight of the affected aggregate simultaneously without changing the batch setting.

- c) **Mixing and Delivery:** Concrete shall be mixed completely in the batching plant. Records shall be kept of water added in normal batching.

Concrete shall be transported to the point of discharge in agitator-mixer trucks, or by other approved means.

Trip tickets shall be provided for each delivery. The tickets shall show the designation of the materials in each batch, measured weight or volume of materials, methods of cooling concrete, class of concrete, batch number, mixer number, batch volume, date and time water was added to the mix, time of discharge from the mixer, and delivery truck number.

When it is necessary to add water to the agitator-mixer, it shall be done in accordance with ASTM C 94 and recorded.

## **6.5 Embedded Items**

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

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 waterstop material, shall permanently develop mechanical strength not less than that of the parent section, and shall permanently retain their flexibility.

- 6.5.2 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 50mm (2 in.) and are spaced not less than three diameters on centres. Except when plans of conduits and pipes are approved by the Engineer, embedded pipes and conduits other than those merely passing through, shall not be larger in outside diameter than one third the thickness of the slab, wall, or beams in which they are embedded nor so located as to impair unduly the strength of the construction. Sleeve pipes, or conduits of any material not harmful to concrete and within the limitations of this section may be embedded in concrete with the approval of the Engineer provided they are not considered to replace the displaced concrete.

- 6.5.3 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.

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

- 6.5.5 **Non Shrink Grout**

Grout of placement under base and bearing plates of steel, machinery and equipment, for grouting anchor bars and dowels and for similar uses shall be as specified. The grout shall be used in accordance with the following and as per manufacturer's recommendations, and as directed by the Engineer.

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

**TABLE I : Gradation of Concrete Aggregates**

Particle Size Square Openings (Equivalent U.S. Sieve Designation)	Percentage by Weight Passing				(Sand)
	Coarse		Fine		
	19 mm to 5 mm	25 mm to 5 mm	37.5 mm to 19 mm	50 m to 25 mm	
	¾"-No.4	1"-No.4	1½ "-3/4"	2"-1"	
63.0 mm (2 1/2 in.)	-	-	-	100	-
50.0 mm (2 in.)	-	-	100	95 – 100	-
37.5 mm (1 1/2 in.)	-	100	90 - 100	35 – 70	-
25.0 mm (1 in.)	100	94 - 100	20 - 55	0 - 15	-
09.0 mm (3/4 in.)	090 –100	-	0 - 15	-	-
12.5 mm (1/2 in.)	-	25 - 60	-	0 - 5	-
09.5 mm (3/8 in.)	20 - 55	-	0 - 5	-	100
05.0 mm (No.4)	0 - 10	0 - 10	-	-	95 - 100
02.36 mm (No. 8)	0 - 5	0 - 5	-	-	-
1.18 mm (No. 16)	-	-	-	-	45 - 80
0.60 mm (No. 30)	-	-	-	-	25 - 55
0.30 mm (No. 50)	-	-	-	-	10 - 30
0.15 mm (No. 100)	-	-	-	-	02 - 10

**TABLE II : Gradation of Combined Coarse and Fine Aggregates for Concrete**

Particle Size Square Openings (Equivalent U.S. Sieve Designation)	Percentage by Weight Passing Sieves				
	Maximum Aggregate Size 50mm	37.5mm	25mm	19mm	9.5mm
63.00 mm (2 1/2 in.)	100	-	-	-	-
50.00 mm (2 in.)	90 - 100	100	-	-	-
37.05 mm (1 1/2 in.)	70 – 90	90-100	100	-	-
25.00 mm (1 in.)	50 - 75	50 - 86	90 - 100	100	-

Particle Size Square Openings (Equivalent U.S. Sieve Designation)	Percentage by Weight Passing Sieves Maximum Aggregate Size				
	50mm	37.5mm	25mm	19mm	9.5mm
19.00 mm (3/4 in.)	45 - 70	45 - 75	55 - 100	90 - 100	-
12.05 mm (1/2 in.)	-	-	-	-	100
09.05 mm (3/8 in.)	38 - 55	38 - 55	45 - 75	60 - 80	90 - 100
05.00 mm (No. 4)	30 - 45	30 - 45	35 - 60	40 - 60	50 - 85
02.36 mm (No. 8)	22 - 35	23 - 38	27 - 45	30 - 45	37 - 52
01.18 mm (No. 16)	15 - 27	17 - 33	20 - 35	20 - 35	25 - 40
00.60 mm (No. 30)	10 - 18	10 - 22	12 - 25	13 - 23	15 - 25
00.30 mm (No. 50)	4 - 10	4 - 10	5 - 15	5 - 15	5 - 15
00.15 mm (No. 100)	1 - 3	1 - 3	1 - 5	1 - 5	1 - 5
0.075 mm (No. 200)	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2

**TABLE III : Quality Tests For Aggregates**

<u>Material</u>	<u>Test</u>	<u>Requirement</u>	<u>Test Designation</u>
Coarse	Abrasion	Loss 40% max.	ASTM C 131
Coarse	Absorption	2.0% max.	ASTM C 127
Coarse	Clay Lumps	1.0% max.	ASTM C 142
Coarse	Surface Coating	0.5% max.	ASTM C 117
Coarse and Fine	Soundness	Loss 10% max.	ASTM C 88
Coarse and Fine	Sieve	As specified	ASTM C 136
Fine	Absorption	4.0% max.	ASTM C 128
Coarse	Cleanness	75% min.	CALIF 227
Fine	Sand equivalent	70% min.	CALIF 217

## 6.5 Concrete for Structures

### 6.5.1 Placing

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

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

6.5.1.2 Concrete shall be deposited continuously, or in layer of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, construction joints shall be located as shown in the Contract Documents or as approved by the Engineer. Placing shall be carried out at such a rate that the concrete, which is being integrated with fresh concrete, is still plastic. Concrete, which has partially hardened, shall not be deposited. Temporary 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.

6.5.1.3 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.

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

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

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

6.5.1.5 Concrete shall be deposited as nearly as possible in its final position to avoid re-handling. 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.

6.5.1.6 The free fall of concrete shall not be allowed to exceed two metre and where it is necessary for the concrete to be placed more than this depth, it shall not 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 diameter of the pipe shall be not less than 225 mm (9 in.).

6.5.1.7 Workmen carrying concrete to the site, and all other workmen, shall move only along runways or planks placed for the purpose and no person shall be allowed to walk on the reinforcement.

## 6.5.2 Consolidation

6.5.2.1 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. Only competent workmen shall operate vibrators. Use of vibrators to transport within forms shall not be allowed.

Vibrators shall be inserted and withdrawn at points approximately 450 mm (18 in.) 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.

6.5.2.2 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.

6.5.2.3 Vibrator shall not be allowed to contact the formwork for exposed concrete surfaces.

6.5.2.4 Mechanical vibrators shall be of a type approved by the Engineer to suit particular conditions.

6.5.3.5 Over-vibration or vibration of very wet mixes shall be avoided.

### 6.5.3 Curing and Protection

6.5.3.1 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.

6.5.3.2 For concrete surfaces not in contact with forms, one of the following procedures shall be applied immediately after completion of placement and finishing, as approved by the Engineer.

- 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 C309.

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

6.5.3.3 Moisture loss from surface placed against wooden forms or metal forms, and 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 as follows by one of the methods specified above.

6.5.3.4 Curing in accordance with sub-clauses 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 and to the same intensity, 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 specified above is used initially, it may be replaced by one of the other specified procedures any time after the concrete is one day old provided the concrete is not permitted to become surface dry during the transition.

6.5.4.5 When the mean daily outdoor temperature is less than 5°C (41°F), temperature of the concrete shall be maintained between 10 and 20 degrees C (50°F-68°F) for the required curing period specified above.

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 with measures to avoid 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.

- 6.5.4.6 When necessary, provision for wind-breaks, shading, spraying, sprinkling, ponding or wet covering with a light coloured material shall be made in advance of placement, and such protective measures shall be taken as quickly as concrete hardening and finishing operation will allow.
- 6.5.4.7 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°C (5.4°F) in any one hour or 10°C (18°F) in any 24 hour period.
- 6.5.4.8 Concrete shall be protected from damaging mechanical disturbances, such as load stresses, heavy shock and excessive vibrations, during the curing period. 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 overstress the concrete.

#### **6.5.5 Works in Extreme Weather**

- 6.5.5.1 Unless adequate protection is provided, and approval is obtained, concrete shall not be placed during rain.

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

- 6.5.5.2 When the temperature of the surrounding air is expected to be below 5°C during placing or within 24 hours thereafter, the temperature of the plastic concrete, as placed, shall be no lower than 13°C for sections less than 300 mm (12 in.) in any dimensions nor 10°C for any other sections.

When necessary, concrete material should be heated before mixing and carefully protected after placing. In general, heating of mixing water alone to about 60°C may be sufficient for this purpose. Dependence should not be placed on salt or other chemicals. Calcium chloride up to a maximum of 1-1/2 percent of the weight of cement may be used to accelerate the rate of hardening only with prior written permission of the Engineer. Use of calcium chloride in excess of 1-1/2 percent is harmful. No frozen material or 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 25 litres per bag of cement.

If water of aggregate is heated above 38°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°C.

- 6.5.5.3 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°C. For mass concreting, this temperature should not exceed 21°C. When the temperature of the concrete exceeds 32°C, precautionary measures approved by the Engineer shall be put into effect. When the temperature of the steel is greater than 50°C, steel forms and reinforcement shall be sprayed with water just prior to placing the concrete. The ingredients shall be cooled before mixing, or ice flakes, or well crushed ice 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 shall also be adopted.

#### **6.5.6 Construction Joints**

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



- 6.5.6.2 Joints not shown on the drawings shall be so made and located as to least impair the strength of the structures 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 floor slabs or beams, and at the top of footings or floor slabs. Beams, brackets, column, capitals, haunches and drop panels shall be placed at the same time as slabs. Joints shall be placed at the same time as slabs. Joints shall be perpendicular to the main reinforcement.
- 6.5.6.3 Reinforcing steel shall continue across the joints. Key and inclined dowels shall be provided as, and where directed by Engineer. Longitudinal keys at least 40 mm (1-5/8 in.) deep shall be provided in all joints in walls and between walls and slabs or footings.
- 6.5.6.4 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.
- 6.5.6.5 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.
- 6.5.6.6 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 13 mm (1/2 in.) thick on horizontal surfaces. The fresh concrete shall be placed before the grout has attained initial set.
- 6.5.6.7 When 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 dislodgement 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 150 mm (6 in.) in thickness, and shall be well rammed against old work, particular attention being paid to corners and closed spots.
- 6.5.6.8 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. Wood strips inserted for architectural treatment shall be kerfed to permit swelling without pressure on the concrete.
- 6.5.7 Expansion Joints
- Expansion joints shall be provided wherever indicated on the Drawings or as directed by the Engineer. In no case shall the reinforcement, or other embedded items be run continuous or through an 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.
- 6.5.8 Embedded Items
- 6.5.8.1 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.

- 6.5.8.2 All embedded items shall be positioned accurately and supported against displacement. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with approved readily removable material to prevent the entry of concrete into the voids.

## **7.0 FINISHING OF FORMED SURFACES**

### **7.1 General**

- 7.1.1 After removal of forms, the surfaces of concrete shall be given one or more of the finishes specified below in locations designated by the Contract Documents.
- 7.1.2 When finishing is required to match a small sample furnished to the Contractor, the sample finish shall be reproduced on an area at least 10 square metres (108 Sft.) 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 defined as 'tolerances', 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 informed as to when finishing of concrete will be performed. Unless inspection is waived in each specific case, finishing of concrete shall be performed only in the presence of the Engineer. Concrete surfaces will be tested by the Engineer where necessary to determine whether surface irregularities are within the limits herein after specified.

Surface irregularities are classified as abrupt or gradual. Offsets caused by displaced or misplaced form sheathing 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 2 metres (6.5 ft.) for testing of formed surfaces and 3 metres (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. The holes and defects shall be patched. Fins exceeding 6 mm (1/4 in.) 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 view. Location of surfaces of concrete structures requiring fair face finish are shown in the Drawings. Surface irregularities, measured as described in sub-clause 7.2.1, 'Rough form finish', all not exceed 6 mm (1/4 in.) for gradual irregularities and 3 mm (1/8 in.) for abrupt irregularities, except that abrupt irregularities will not be permitted at construction joints. Abrupt irregularities at construction joints and elsewhere in excess of 3 mm (1/8 in.) and gradual irregularities in excess of 6 mm (1/4 in.) shall be reduced by grinding so as to conform to the

specified limits. Abrupt irregularities at construction joints shall be ground on 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, 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. The holes and defects shall be patched. All fins shall be completely removed.

## **8.0 REPAIR OF 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 replace at the Contractor's expense.

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

### **8.2 Repair of Defective Areas**

- 8.2.1 Defective and honeycombed concrete shall be removed down to sound concrete. The area to be patched and an area at least 150 mm (6 in.) 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 less than 1 part cement to 2-1/2 parts sand by weight. 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 color 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 lose 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 at least 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 0.2 square metre (2 square foot) in each 100 square metres (1076 square foot) 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 at least 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.

## 9.0 CONCRETE CONSTRUCTION TOLERANCES

All tolerances shall be as per ACI 317.

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 his responsibility for correct fitting of indicated materials and components. These tolerances are not cumulative.

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

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

In any 3 metres (10 ft.) of length or height	6 mm (1/4 in.)
--	----------------

Maximum for the entire length or height	25 mm (1 in.)
---	---------------

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

In any bay or 6 metres (20 ft.) maximum	6 mm (1/4 in.)
---	----------------

Maximum for the entire length or height	13 mm (1/2 in.)
---	-----------------

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

9.2.1 In beam soffits, and in arises measured before removal of supporting shores.

In any 3 metres (10 ft.) of length	6 mm (1/4 in.)
------------------------------------	----------------

In any bay or in any 6 metres (20 ft.) maximum	10 mm (3/8 in.)
--	-----------------

Maximum for the entire length	19 mm (3/4 in.)
-------------------------------	-----------------

- 9.3 Variation of the linear structure lines from established position in plan and related position of columns and walls.
- |                               |   |
|-------------------------------|---|
| In any bay or 6 metres        | $\pm 13 \text{ mm } (\pm 1/2 \text{ in})$ |
| Maximum for the entire length | $\pm 25 \text{ mm } (\pm 1 \text{ in.})$  |
- 9.4 Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls.
- |                       |   |
|-----------------------|---|
| Up to 12" (300mm)     | - 6 mm ( - ¼ in.)<br>+10 mm ( + 3/8 in.)  |
| More than 12" (300mm) | - 10 mm ( - 3/8 in.)<br>+13 mm ( + ½ in.) |
- 9.5 **Footings**
- 9.5.1 Variation in dimensions in plan
- |   |                |
|---|----------------|
| Minus   | 13mm (1/2 in.) |
| Plus (plus variation applied to concrete only, not to the reinforcing bars or dowels). (formed) | 50mm (2 in.)   |
- 9.5.2 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). | + 50mm ( + 2 in.) |
|--|-------------------|
- 9.5.3 Reduction in thickness
- |  |  |
|--|--|
| Minus 5 percent of specified thickness |  |
|--|--|
- 10.0 **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 as decided by the Engineer or if misplaced items interfere with other construction.
- 10.2.4 Inaccurately formed concrete surfaces exceeding the limits of Clause 9 or of Clause 6.5 of Section 'Formwork' shall be removed and replaced, and those that are exposed to view, may be rejected, or shall be repaired, or removed and replaced, as directed by the Engineer.

### 10.3 **Appearance**

- 10.3.1 Architectural concrete with surface defects exceeding the limitations described in relevant Clauses of this section 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 reason of defective appearance.

### 10.4 **Strength of Structure**

- 10.4.1 Strength of the structure in place will be considered potentially deficient if it fails to comply with any requirement which is relevant to 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 specified under section '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, premature removal of formwork, likely to result in deficient strength.
  - Poor workmanship likely to result in deficient strength.
- 10.4.2 Structural computations 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 deficient.
- 10.4.4 If core tests are inconclusive or impractical to obtain or if structural computations do not confirm the safety of the structure, load tests may be required and their results evaluated, in accordance with ACI Standard 318.
- 10.4.5 Concrete work judged inadequate by structural computations 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 bear all costs incurred in providing the additional testing and/or computations required by this section.

## **11.0 MEASUREMENT AND PAYMENT**

### **11.1 General**

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

11.1.1 All types of formwork including shoring/bracing/scaffolding etc.

11.1.2 All types of expansion, construction and contraction joints

11.1.3 All sampling, mixing and testing as specified.

11.1.4 Concrete mix design.

11.1.5 Vapour barrier.

11.1.6 Impervious sheeting, burlap covering, liquid membranes compound, additives, non-shrink grout and epoxy resins.

11.1.7 Anchor bolts and other embedded parts.

11.1.8 All submittals including shop drawings, co-ordination drawings etc.

11.1.9 Repair and replacement of defective work.

11.1.10 Surface texture, skid resistant surfaces & surface test.

11.1.11 Curing

11.1.12 Installation / fixing in position of all precast / prefabricated concrete elements, as shown on drawings.

11.1.13 Tie bars, dowel bars, dowel bar sleeves and welded wire mesh.

11.1.14 Concrete Admixtures

### **11.2 Plain and Reinforced Concrete**

#### **11.2.1 Measurement**

Measurement of acceptably completed works of plain and reinforced concrete will be made on the basis of number of cubic metre / cubic foot of concrete actually provided, placed, consolidated, finished, cured in position, complete as shown on drawings or as directed.

#### **11.2.2 Payment**

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

### 11.3 **Water Stopper**

#### 11.3.1 Measurement

Measurement of acceptably completed works of water stopper will be made on the basis of running metre / running foot of water stopper actually provided, placed in position, complete as shown on drawings or as directed.

#### 11.3.2 Payment

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

### 11.4 **C.C Jali**

#### 11.4.1 Measurement

Measurement of acceptably completed works of c.c jali will be made on the basis of square metre / square foot of cement concrete jali actually provided, placed in position, complete as shown on drawings or as directed.

#### 11.4.2 Payment

Payment will be made for the acceptable measured quantity of c.c jali on the basis of unit rate per square metre / 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 2300 \*\*\*



**SECTION - 4600**  
**CARPENTRY AND JOINERY**

- 1. SCOPE**
- 2. APPLICABLE STANDARDS**
- 3. MATERIALS**
- 4. SAMPLES**
- 5. FABRICATION**
- 6. PROTECTION OF MATERIALS**
- 7. WOODEN DOORS**
- 8. WOODEN CABINETS**
- 9. WOODEN RAILING**
- 10. DEFECTIVE WORK**
- 11. SURFACE PREPARATION**
- 12. MOCK-UP SAMPLE**
- 13. MEASUREMENT AND PAYMENT**

## **SECTION - 4600**

### **CARPENTRY AND JOINERY**

#### **1.0 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.

#### **2.0 APPLICABLE STANDARDS**

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

##### **2.1 ISO (International Organization for Standardization)**

- 1891 Bolts, screens, nuts and accessories-Terminology and nomenclature.
- 1097 Plywood - Measurement of dimensions of panels.
- 1098 Veneer ply wood for general use-General requirements.
- 2427 Veneer ply wood with rotary cut veneer for general use-Classification by appearance of panels with outer veneer of beech.
- 2429 Ply wood -Veneer ply wood with rotary cut veneer for general use-Classification by appearance of panels with outer veneers of brand leaved species of tropical Africa.
- 3804 Ply wood-Determination of dimension of test pieces.
- 3805 Ply wood-Determination of density.
- 3806 Ply wood-Determination of moisture content.
- 6442 Door leaves-Measurement of defects of general flatness.
- 6443 Door leaves-Measurement of dimensions and of defects of squareness.
- 6444 Door leaves-Test of behaviour under humidity variations.

##### **2.2 BSI (British Standards Institution)**

- 459 Wooden doors.
- 1186 Quality of timber and workmanship in joinery.
- 1127 Hinges
- 1331 Builder's hardware for housing.
- 1567 Wood door frames and linings nails.
- 1202 Nails
- 1203 Specifications for synthetic resin adhesive for ply wood.

- 1204 Synthetic resin adhesives for wood.
- 1282 Guide to choice, use and application of wood preservatives.
- 1494 Fixing accessories for building purposes.
- 1579 Connectors for timber.
- 3842 Treatment of ply wood with preservatives.

### **3.0 MATERIALS**

#### **3.1 Timber**

##### **3.1.1 Hard Wood:**

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

##### **3.1.2 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.

##### **3.1.3 General Characteristics:**

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

The whole of the timber shall be from the heart of sound and fully grown tree, uniform in substance, straight in 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.

##### **3.1.4 Preservation of Wood:**

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

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

##### **3.1.5 Adhesive:**

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

##### **3.1.6 Nails and Screws:**

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

### 3.2 Ply Wood

The ply wood shall comply in all respects with BSI No. 1455:1963. Before procurement, the supplier should be got 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.

### 3.3 Medium Density Fiber (MDF) Board

Medium density fiber board to be used on the project shall be LASANI make or approved equivalent 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.

## 4.0 **SAMPLES**

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

## 5.0 **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.

## 6.0 **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.

## 7.0 **WOODEN DOORS**

### 7.1 Materials

7.1.1 First class wood as indicated on drawings or as approved by the Engineer shall be used for door shutters except the core of shutters which shall be honeycomb fiber to form 12mm air cell as specified and shown on drawings. Door frames shall be of painted steel/hard wood as shown on drawings.

7.1.2 Architraves, beads, lippings shall be of wood as indicated on drawings or as approved by the Engineer of specified sizes and fixed as per details shown on Drawings.

## 7.2 Ground, Blocking & Nailing Strips

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

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

- 7.2.1 To steel: by means of 10mm diameter bolts spaced not over 1 meter.
- 7.2.2 To block wall: by the use of cut nails spaced not more than 0.5 meter apart and driven directly into the block.
- 7.2.3 To poured concrete: by means of 6 mm diameter galvanized expansion bolts spaced not more than 0.5 meter part or by any approved method.

## 7.3 Exterior and Interior Door Frames

All exterior and interior door frames shall be fabricated of steel sections or wood as shown on drawings.

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

## 7.4 Door Shutters

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

- 7.4.1 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.
- 7.4.2 The door shutters shall be built in sections, properly jointed and glued together. The surfaces shall be prepared for painting or polishing.
- 7.4.3 Each door shall be constructed so as to permit the installation of hinges, knobs and locks in the position shown on the Drawings. Lock rails should also be provided with all flush doors.
- 7.4.4 Completed doors shall be sound, rigid and free from defects and warp. All edges shall be aligned and smooth, joints shall be close fitting, hard wood doweled or mortised framed and of strength to maintain frame and of strength to maintain the structural properties of the member connected. All adjoining faces and edges shall be flush and smooth. Edges shall be rectangular and solid.
- 7.4.5 All exposed surfaces of wooden frames and wooden shutters shall be lacquered or painted with synthetic matt finished enamel paint of approved shade as per the instructions of the Engineer.
- 7.4.6 Chamfers shall be made as shown on the drawings or as directed by the Engineer.

## 7.5 Fitting, Hanging and trimming

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

Doors shall have a clearance of 3mm (1/8 in.) at sides and top unless otherwise directed by the Engineer and shall have 5mm (1/4 in.) clearance at bottom. For external doors provide dust proof strip at bottom and for sound proof/ fire rated door provide neoprene strip at door frame interface. 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.

#### 7.6 Hardware

Hardware shall be of best quality local make extra heavy duty and first class finished material except door locks and door closures which shall be imported of 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.

#### 7.7 Quality Assurance

7.7.1 Tolerances: Doors shall be fabricated to following tolerances

- Size: Plus or minus 1.5mm (1/16 in.) in overall dimensions
- Maximum Warp: 3mm (1/8 in.)
- Squareness: Maximum diagonal difference 3mm (1/8 in.) 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).

7.7.2 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.

#### 7.8 Submittal

7.8.1 Provide manufacturer's literature completely describing products.

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

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

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

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

#### 7.9 Product Delivery, Storage and Handling

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

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

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

#### 7.10 Installation

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

7.10.2 Install finish hardware in accordance with manufacturer directions.

### 8.0 **WOODEN CABINETS**

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

#### 8.1 Shop Drawings

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

#### 8.2 Installation

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

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

All work shall be thoroughly protected from damage at all times by suitable methods approved by the Engineer. Adjacent work shall similarly be protected from, damage. Any damage or disfigurement shall immediately be corrected at Contractor's expense.

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

8.4 Cabinet work, generally all framing will be in treated hardwood with portions etc. in best quality commercial plywood. All exposed surfaces will be covered by approved laminates. Exposed edges, if any, will be covered by polished hardwood lipping.

### 9.0 **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.

## **10.0 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.

## **11.0 SURFACE PREPARATION**

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

## **12.0 MOCK-UP SAMPLE**

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

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

## **13.0 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.

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

13.11.2 Prime coat, final finishing painting with enamel paint/ lacquer polishes in carpentry and joinery works/ hand railing.

13.11.3 Anti termite treatment to wood works and adhesives

13.11.4 Steel balusters, steel base and steel strip for wooden railing.

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

13.11.6 Wastage of material.

13.11.7 Deodar wood beading/architraves, commercial ply, veneered block board shutter



13.12 Wooden Cabinets / Wardrobes (floor/wall mounted)

13.12.1 Measurement

Measurement of acceptably completed work of floor/wall mounted wooden cabinets and wardrobes will be made on the basis of surface area in square meter / square foot of kitchen cabinets provided and installed in position as shown on the Drawings or as directed by the Engineer.

13.12.2 Payment

Payment will be made for acceptable measured quantity of floor/wall mounted wooden cabinets and wardrobes 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 4600 \*\*\*

**SECTION - 6220**  
**ALUMINUM WORKS**

- 1. SCOPE**
- 2. APPLICABLE STANDARDS**
- 3. GENERAL**
- 4. MATERIAL**
- 5. DESIGN REQUIREMENT**
- 6. WORKMANSHIP**
- 7. PRODUCT DELIVERY AND STORAGE**
- 8. ERECTION**
- 9. PROTECTION AND CLEANING**
- 10. DEFECTIVE WORK**
- 11. GUARANTEE**
- 12. MEASUREMENT & PAYMENT**

**SECTION - 6220**  
**ALUMINUM WORKS**

**1.0 SCOPE**

The work under this section of specification includes furnishing all labour, equipment, appliances and materials and performing all operations in carrying out the work of aluminium doors, windows, ventilators and louvers. All related items such as sealants, rubber gasket for glazing, fly proofing, rollers, latches, fastenings, glazing, anchor bolts and all items supplied by other trades and customarily built in and/or installed in strict accordance with this section of the specifications and the applicable drawings and subject to the terms and conditions of the Contract.

**2.0 APPLICABLE STANDARDS**

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

**2.1 ISO (International Organisation for Standardisation)**

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

**2.2 BSI (British Standard Institution)**

- 1227 Hinges
- 4873 Aluminium alloy windows.

**3.0 GENERAL**

- 3.1 Doors, windows and ventilators to be provided shall be aluminium doors, windows and ventilators of profile, pattern and design shown on drawings and shop drawings as approved by the Engineer. The Contractor shall provide manufacture literature completely describing the product instructions for installation and maintenance.
- 3.2 All the sections used for doors, windows and ventilators shall be of best quality aluminium products such as equal and unequal angles, channels, tubes, corrugated strips, mouldings etc., in accordance with International standards conforming to ASTM B 308 & B 221.
- 3.3 All doors, windows and ventilators, shall be of type and size indicated on drawings and shall conform to the requirements shown and specified herein.
- 3.4 Contractor shall arrange tests and analysis if directed by the Engineer of scaled models of each doors, windows and ventilators type at the maker's works or any laboratory specified by the Engineer for the material supplied by him to be tested in the presence of the Engineer's Inspector, to whom test certificates, proof sheets, etc. shall be furnished. The models shall be submitted to the Engineer for approval prior to testing.

Nevertheless, neither the fact that the materials have been tested in the presence of the Inspector nor that the Engineer may have been furnished with test certificates in lieu of sending an inspector to the works shall affect the liberty of the Engineer to reject, after delivery of materials found not in accordance with these specifications.

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

After approval of shop drawings and tests etc., the Contractor shall submit at his own cost one mock-up sample of each type of aluminium works complete with glazing, all components assembly method and required fittings and accessories prior to the actual fabrication of the bulk. The samples shall be returned to the Contractor for incorporation in the works after installation of at least 80% of the works.

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

- 3.6 The glass shall conform to specification laid down under chapter 'Glazing' and shall be free from all blemishes, bubbles, distortions and other flaws of any kind and shall be properly cut to size as shown on drawings, so as to fit the grooves in ventilators members. All the glass shall be best quality of approved manufacture or equivalent standard as approved by the Engineer.
- 3.7 The structural shape of the aluminium members shall be of uniform quality, colour and temper, clean, round, commercially straight and free from injurious defects.
- 3.8 All doors, windows and ventilators shall be fabricated as a complete unit, fully airtight and watertight, including rubber gasket for glazing, rollers, latch, anodized in specified colour, inclusive of glass sheet, all as approved by the Engineer.
- 3.9 Contractor shall, on request, get certificate signed by the manufacturer stating that each lot has been sampled, tested and inspected and has met the requirements in accordance with these specifications, and the same shall be furnished to the Engineer.
- 3.10 The shop drawings shall clearly show that there shall be no penetration of rainwater from the exterior to the interior in case of severe wind and rainstorm. This has to be specially ensured in cill section.

#### **4.0 MATERIAL**

##### **4.1 Frames/shutters**

The frames of aluminium door, windows and ventilator shall be formed from rolled, strip or extruded aluminium. The thickness of sectional members shall be at least 1.6 mm. All outer / frame sections of openable / fixed windows. Ventilators and louvers curtain wall shall be 3" (75 mm) minimum in width. The Frames for doors and door/windows curtain wall shall be at least 3" (75 mm) in width.

- 4.2 As shown on the drawings, aluminium frames shall be provided as per international standard approved by the engineer.
- 4.3 Fasteners shall be stainless steel of a type selected to prevent galvanic action with the components fastened.
- 4.4 Gaskets shall be vinyl glazing channel gasket to commercial standard CS-230-60.

- 4.5 Hardware shall be manufacturer's standard hardware. Flush to match doors, windows, ventilators and louvers finish. Floor mounted concealed type double action/swing imported door closures shall be provided to all doors. Heavy-duty in-matching finish stays shall be provided to all openable windows, ventilators and louvers. Stays shall be attached to the window frame so as could be replaced easily.
- 4.6 Joint sealant shall be approved elastomer.
- 4.7 All aluminium sections shall be powder coated in accordance with the standards of Aluminium Association of USA. The anodisation shall be of not less than 70-90 microns. The anodic oxide surface shall be properly sealed.
- 4.8 For powder coated finish aluminium sections to be coated shall be mill finish. The sections shall be firstly degreased with a degreasing chemical to remove all/any stains. The sections will then be given a chromating coating and electro static powder coating in the desired colour with a powder-coating machine. After colour coating the sections will be baked at baking temperature of 220 degree Centigrade for 25 minutes.
- 4.9 All sliding/openable windows shall have sliding/openable wire/fly screen shutters in window matching finish with wire/fly screen of size so as not to permit the entry of flies and mosquitoes. The wire mesh shall be 30 SWG. 14 mesh (14 x 14 openings per square inch).
- 4.10 Composite Aluminium Cladding: Composite aluminium cladding material shall be from approved manufacturer.

## 5.0 **DESIGN REQUIREMENT**

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

### 5.1 **Tolerances**

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

### 5.2 **Thermal & Seismic Movements**

The window and glazing assemblies are to be constructed and installed in the openings with sufficient tolerance and, where necessary, to provide for joints incorporated in couplings, to provide for expansion and contraction as will be caused by the local seismic and climatic conditions and temperature changes, winter to summer - day to night without buckling, distortion of joints, or other harmful effects.

## 6.0 **WORKMANSHIP**

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

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

## **7.0 PRODUCT DELIVERY AND STORAGE**

- 7.1 Deliver doors, windows and ventilators in a manner preventing damage to units. Store materials off the ground under cover in a manner preventing deterioration or damage.
- 7.2 All embedded parts and anchor bolts shall be delivered to the site carefully and keeping the fabricated shape and configuration. All these parts shall be suitably marked for identification.

## **8.0 ERECTION**

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

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

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

## **9.0 PROTECTION AND CLEANING**

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

## **10.0 DEFECTIVE WORK**

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

## **11.0 GUARANTEE**

- 11.1 The manufacturer shall furnish his standard written guarantee against leakage of rain, excessive infiltration of dust and air and all defects in materials and workmanship covering all work under this section.
- 11.2 Such guarantee shall be in addition to and not in lieu of all other liabilities which manufacturers and the Contractor may have by law or by other provisions of the Contract Documents.

## **12.0 MEASUREMENT AND PAYMENT**

### **12.1 General**

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

- 12.1.1 Providing and fixing glazings.

12.1.2 Powder coating of Aluminium works.

12.1.3 Anodizing of Aluminium works.

12.1.4 Rawlplugs, brackets, rubber gasket, sealants, rollers, vetting latches and any other embedded fixture required for fixing the ventilators.

12.1.5 Providing & fixing locks, door closures, and other hardware as approved by the Engineer.

12.1.6 Fly proof shutters and screens for Doors & windows.

12.1.7 All samples and tests.

12.1.8 Insulation, structural steel for framing etc. for cladding.

## 12.2 **Aluminium Works**

### 12.2.1 Measurement

Measurement of acceptably completed works of aluminium doors, windows, ventilators and louvers will be made on the basis of actual area in square meter / square foot of door, windows and ventilators provided and installed in position as shown on drawings or as directed by the Engineer.

### 12.2.2 Payment

Payment will be made for acceptable measured quantity of aluminium door, windows, ventilators and louvers 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 6220 \*\*\*

## **SECTION - 6411**

### **WATER PROOFING/EXPANSION JOINT FILLING & BUILT UP ROOFING**

- 1. SCOPE**
- 2. SUBMITTAL**
- 3. MATERIALS**
- 4. DELIVERY, STORAGE AND HANDLING**
- 5. PREPARATORY WORK**
- 6. WATER PROOFING TREATMENT IN FOUNDATIONS AND SURFACES IN CONTACT WITH EARTH**
- 7. APPLICATION OF WATER PROOFING TO UNDERGROUND WATER RETAINING STRUCTURES**
- 8. EXPANSION JOINT FILLING**
- 9. MEASUREMENT & PAYMENT**



## **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<sup>2</sup>.
- 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 of 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 - 6600**  
**FLOOR AND WALL FINISHES**

- 1. SCOPE**
- 2. MATERIALS**
- 3. CEMENT CONCRETE FLOORING**
- 4. INSTALLATION OF TILE FLOORING**
- 5. IRONITE FLOOR TOPPING**
- 6. MEASUREMENT AND PAYMENT**

## 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**

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

## **SECTION - 6700**

### **PAINTING**

#### **1.0 SCOPE**

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

#### **2.0 APPLICABLE STANDARDS**

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

##### **2.1 BSI (British Standards Institution)**

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

#### **3.0 GENERAL**

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

#### **4.0 MATERIALS**

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

#### **5.0 DELIVERY STORAGE AND CONTAINER SIZES**

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

#### **6.0 SURFACE PREPARATION**

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

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

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

## 7.0 APPLICATION

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

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

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

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

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

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

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

## 8.0 JOB CONDITIONS

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

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

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

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

## **9.0 QUALITY ASSURANCE**

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

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

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

## **11. MEASUREMENT AND PAYMENT**

### **11.1 General**

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

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

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

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

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

### **11.2 Painting / Acrylic based textured Coating**

#### **11.2.1 Measurement**

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

#### **11.2.2 Payment**

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

\*\*\* End of Section 6700 \*\*\*



# **ELECTRICAL WORKS**

## **SECTION - 8001**

### **GENERAL SPECIFICATIONS FOR ELECTRICAL WORKS**

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

## **1.0 SCOPE OF WORK**

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

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

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

## **2.0 RULES & REGULATIONS**

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

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

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

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

### **3.0 AMBIENT CONDITIONS**

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

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

The atmospheric conditions are tropical and highly humid.

### **4.0 STANDARDS**

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

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

### **5.0 SYSTEM DATA**

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

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

b) Frequency : 50Hz  $\pm$  2Hz

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

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

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

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

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

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

#### Control Cables

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

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

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

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

## **6.0 EQUIPMENT**

### **6.1 IP Degree of Protection**

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

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

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

### **6.2 Identification & Labelling**

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

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

### **6.3 Lamp Test Facility**

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

## **7.0 DRAWINGS AND DATA TO BE FURNISHED BY THE CONTRACTOR**

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

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

elevation and sections on a suitable scale.

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

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

## **8.0 MANUFACTURER'S INSTRUCTIONS**

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

## **9.0 GUARANTEE**

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

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

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

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

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

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

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

#### **11.0 ASSOCIATED CIVIL WORKS**

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

#### **12.0 INSTALLATION INSTRUCTIONS - GENERAL**

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

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

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



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

### **13.0 FACTORY TESTS**

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

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

### **14.0 TESTING - GENERAL**

#### **14.1 Scope**

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

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

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

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

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

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

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

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

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

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

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

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

#### Battery Charger

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

#### Control Panel

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

### **14.3 Transformer Tests**

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

### **14.4 HT / LT Switchboards**

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

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

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

#### **14.5 Insulation Resistance Test**

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

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

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

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

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

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

#### **14.6 Earth Resistance Test**

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

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

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

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

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

#### **14.7 Completed Tests**

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

#### **14.8 Expenses**

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

#### **14.9 Spare Parts**

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

#### **14.10 Special Tools**

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

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

#### **15.0 APPENDICES TO BE FILLED IN BY THE BIDDER**

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

#### **16.0 PAYMENT**

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

\*\*\* End of Section 8001 \*\*\*

## **SECTION - 8133**

### **LT DISTRIBUTION BOARDS**

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

## 1.0 SCOPE OF WORK

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

The Contractor shall discuss the electrical layout with the Engineer and 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:

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

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

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



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

### **3.0 APPLICABLE STANDARDS/CODES**

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

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

### **4.0 MATERIAL**

#### **4.1 Sheet Metal Work**

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

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

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

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

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

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

## 4.2 **Components**

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

Typical component specifications are given below:

### 4.2.1 Bus Bars

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

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

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

#### 4.2.2 Moulded Case Circuit Breaker (MCCB)

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

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

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

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

#### 4.2.3 Ammeters and Voltmeters

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

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

#### 4.2.4 Current Transformers

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

#### 4.2.5 Selector Switches

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

#### 4.2.6 Air Break Contactors

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

#### 4.2.7 Push Buttons

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

#### 4.2.8 Indicating Lamps

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

#### 4.2.9 Impulse Relay

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

#### 4.2.10 Line up Terminals

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

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

## **5.0 INSTALLATION**

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

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

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

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

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

## **6.0 MEASUREMENT AND PAYMENT**

### **6.1 General**

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

### **6.2 LT Distribution Boards (DBs)**

#### **6.2.1 Measurement:**

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

#### **6.2.2 Payment:**

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

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

\*\*\* End of Section 8133 \*\*\*

## **SECTION - 8111**

### **LOW VOLTAGE D.G. SET**

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

## **1.0 SCOPE OF WORK**

The work under this section consists of supply, installation, testing and commissioning of all material and services of the complete Diesel generator set, Auto Main Failure (AMF) Panel and other equipment, as specified herein, shown on the Tender Drawings and given in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and co-ordinate at Site with other services for exact location and position of the Diesel Generator Set, Auto-Main Failure (AMF) Panel, underground / above ground storage tanks and routing of cables.

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

## **2.0 GENERAL**

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

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

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

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

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



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

The set shall be capable for parallel operation.

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

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

### **3.0 APPLICABLE STANDARDS/CODES**

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

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

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

### **4.0 MATERIAL**

#### **4.1 Diesel Engine**

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

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

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

The batteries shall be adequate to satisfy the following requirements:

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

#### 4.1.1 Air Intake

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

#### 4.1.2 Engine Lubrication

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

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

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

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

#### 4.1.3 Engine Cooling

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

#### 4.1.4 Exhaust System, Noise, Pollution

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

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

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

#### 4.1.5 Speed Governor

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

### 4.2 **Fuel System**

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

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

#### 4.2.1 Underground Fuel Storage Tank

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

#### 4.2.2 Fuel Transfer Pumps

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

#### 4.2.3 Fuel Piping Network

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

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

#### 4.2.4 Fuel Day Tank

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

### 4.3 **Generator**

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

#### 4.3.1 Excitation

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

#### 4.3.2 Windings

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

#### 4.3.3 Voltage Regulation

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

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

#### 4.3.4 Short Circuit Capability

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

#### 4.3.5 Deviation Factor

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

#### 4.4 Control / Instrument Panels

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

##### 4.4.1 Generator Panel

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

##### 4.4.1.2 Instruments

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

##### 4.4.2 Engine Panel

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

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

##### 4.4.3 Safety Devices

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

A = Alarm SD = Shutdown TD = Adjustable Time Delay

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



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

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

#### 4.4.3 Batteries & Battery Charger

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

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

#### 4.4.5 Lamp Test Facility

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

### 4.5 **Automatic Transfer Switch (ATS)**

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

## **5.0 INSTALLATIONS & TESTING**

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

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

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

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

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

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

## **6.0 MEASUREMENT AND PAYMENT**

### **6.1 General**

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

## **6.2 Diesel Generator Set**

### **6.2.1 Measurement**

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

### **6.2.2 Payment**

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

## **6.3 Fuel System**

### **6.3.1 Measurement:**

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

### **6.3.2 Payment**

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

## 6.4 **Spare Parts**

### 6.4.1 Measurement

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

### 6.5.2 Payment

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

\*\*\* End of Section 8111 \*\*\*

## **SECTION - 8133**

### **LT DISTRIBUTION BOARDS**

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

## 1.0 SCOPE OF WORK

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

The Contractor shall discuss the electrical layout with the Engineer and 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 gasketing and a lockable hinged door with cam fastener.

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

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

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

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

## **4.2 Components**

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

Typical component specifications are given below:

### **4.2.1 Bus Bars**

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

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



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

#### 4.2.2 Moulded Case Circuit Breaker (MCCB)

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

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

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

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

#### 4.2.3 Ammeters and Voltmeters

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

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

#### 4.2.4 Current Transformers

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

#### 4.2.5 Selector Switches

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

#### 4.2.6 Air Break Contactors

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

#### 4.2.7 Push Buttons

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

#### 4.2.8 Indicating Lamps

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

#### 4.2.9 Impulse Relay

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

#### 4.2.10 Line up Terminals

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

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

## **5.0 INSTALLATION**

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

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

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

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

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

## **6.0 MEASUREMENT AND PAYMENT**

### **6.1 General**

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

### **6.2 LT Distribution Boards (DBs)**

#### **6.2.1 Measurement:**

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

#### **6.2.2 Payment:**

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

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

\*\*\* End of Section 8133 \*\*\*

## **SECTION - 8150**

### **LIGHT FIXTURES**

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

## **1.0 SCOPE OF WORK**

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

The Contractor shall discuss the electrical layout with the Engineer and co-ordinate at Site with other services for exact locations and positions of the light fixtures.

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

## **2.0 GENERAL**

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

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

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

## **3.0 APPLICABLE STANDARDS/CODES**

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

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

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

## 4.0 MATERIAL

### 4.1 LED Essential/Waterproof Batten Light Fixture:

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

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

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

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

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

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

manufacturing defects.

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

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

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

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

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

#### **4.2 LED Smart Panel Light Fixture:**

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

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



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

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

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

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

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

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

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

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

#### **4.3 LED Down Light Fixtures**

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

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

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

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

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

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

#### **4.4 Compact Fluorescent Light Fixtures**

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

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

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

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

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

#### **4.5 Exit Sign – Emergency Light Fixture**

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

#### **4.6 LED Flood Light Fixture**

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

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

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

#### **4.7 High Pressure Sodium Lamp**

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

#### **4.8 Ballast for High Pressure Sodium Lamps**

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

#### **4.9 Electronic Ignitors for High Pressure Sodium Lamps**

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

#### **4.10 Capacitors for High Pressure Sodium Lamps**

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

#### 4.11 Flood Light Lanterns

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

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

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

#### 4.12 LED Street Light Fixture

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

#### **4.13 LED Chips and Driver**

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

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

The LED driver shall fully conform to following specifications:-

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

## **5.0 INSTALLATION**

### **5.1 General**

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

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

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

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

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

#### **5.2 Street Light / Flood Light Fixture**

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

#### **5.3 Flood Light Lanterns**

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

#### **5.4 LED Batten / Panel Light Fixture:**

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

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

#### **5.5 LED Down Light Fixture**

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



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

## **6.0 MEASUREMENT AND PAYMENT**

### **6.1 General**

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

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

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

#### **6.2.1 Measurement**

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

#### **6.2.2 Payment**

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

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

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

shown on the Bidding Drawings related to the item.

6.3.1 Measurement

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

6.3.2 Payment

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

\*\*\* End of Section 8150\*\*\*

## **SECTION - 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 Engineer 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 3/4" 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 - 8240**

### **EARTHING**

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

## **1.0 SCOPE OF WORK**

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

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

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

## **2.0 GENERAL**

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

## **3.0 APPLICABLE STANDARDS/CODES**

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

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

## **4.0 MATERIAL**

### **4.1 Earth Electrode**

#### **4.1.1 Plate Type**

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

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

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

#### 4.1.2 Copper Clad Steel Rod Type

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

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

### 4.2 Earthing Lead

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

### 4.3 Earth Continuity Conductor

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

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

#### **4.4 Earth Connecting Point**

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

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

### **5.0 INSTALLATION**

#### **5.1 General**

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

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

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

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

#### **5.2 Earth Electrode**

##### **5.2.1 Plate Type**

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

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

#### **5.2.2 Copper Clad Steel Rod Type**

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

### **5.3 Earth Continuity Conductor**

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

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

### **5.4 Earth Connecting Point**

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

## **6.0 MEASUREMENT AND PAYMENT**

### **6.1 General**

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

## **6.2 Earth Electrode**

### **6.2.1 Measurement:**

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

### **6.2.2 Payment:**

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

## **6.3 Earth Continuity Conductor (ECC)**

### **6.3.1 Measurement:**

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

### **6.3.2 Payment:**

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

## **6.4 Earth Connecting Point**

### **6.4.1 Measurement:**

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

### **6.4.2 Payment:**

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

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

\*\*\* End of Section 8240 \*\*\*



## **SECTION - 8290**

### **MISCELLANEOUS ITEMS**

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

## **1.0 SCOPE OF WORK**

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

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

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

## **2.0 GENERAL**

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

## **3.0 APPLICABLE STANDARDS/CODES**

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

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

## **4.0 MATERIAL**

### **4.1 MCCB / MCB Enclosed in Sheet Steel Box**

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

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

#### **4.2 Load Break Switch Enclosed in Sheet Steel Box**

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

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

#### **4.3 Exhaust Fans**

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

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

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

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

#### **4.4 Cable Trays / Trunking**

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

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

#### 4.4.1 M.S. (Mild Steel) Cable Trunking

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

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

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

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

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

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

### **5.0 INSTALLATION**

#### **5.1 General**

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

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

The triple pole moulded case circuit breakers (MCCB) single/double pole miniature circuit breakers (MCB) shall be installed on 1.63 mm (16 SWG) thick sheet steel box with screws or some suitable arrangements as approved by Engineer. White faceplate for sheet steel box shall be fixed by means of flat head galvanized screws sunk in the plastic plate so as to finish flush with the wall surface. The edges of the plate shall be 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**
- 2.0 GENERAL**
- 3.0 APPLICABLE STANDARDS/CODES**
- 4.0 MATERIAL**
- 5.0 INSTALLATIONS**
- 6.0 TESTING AND COMMISSIONING**
- 7.0 MEASUREMENT AND PAYMENT**



## **1.0 SCOPE OF WORK**

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

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

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

## **2.0 GENERAL**

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

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

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

## **3.0 APPLICABLE STANDARDS AND CODES**

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

EIA/TIA 568-A      Commercial Building Telecommunications Cabling Standard.

EIA/TIA 569-A      Commercial Building Telecommunications Cabling Standard Pathways and Spaces.

TSB 67              Transmission Performance Specifications for Field-Testing of Unshielded Twisted-Pair Cabling Systems.

IEEE 802.3          Wire Speed Performances

IEEE 802.1Q        VLAN

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

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

## 4.0 MATERIALS

### 4.1 Category – 6 UTP Cable

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

#### Electrical Specification

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

#### Mechanical Specification

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

### 4.2 Category – 6 RJ-45 Outlets

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

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

#### **Electrical Specification**

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

#### **Mechanical Specification**

##### **Jack Contact**

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

##### **IDC Block**

- Material of metal terminals - Copper alloy
- Wire Accommodation (diameter range) - AWG 22-24
- Tool Accommodation (required or not) - NO
- 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 - 8331**

### **FIRE ALARM SYSTEM**

- 1.0 SCOPE OF WORK**
- 2.0 GENERAL**
- 3.0 APPLICABLE STANDARDS/CODES**
- 3.0 MATERIAL**
- 5.0 INSTALLATION**
- 4.0 TRAINING**
- 7.0 MEASUREMENT AND PAYMENT**

## **1.0 SCOPE OF WORK**

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

The Contractor will discuss the fire alarm system layout with the Engineer and coordinate at site with other services for exact route, location and position of electrical lines and equipment.

The Fire Alarm 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 outlet boxes shall be considered part of the devices installed on them and shall be supplied alongwith the devices.

The system shall operate on 24 VDC from a battery charger with standby batteries. The incoming supply shall be 230 VAC from emergency circuit.

Contractor shall provide following information on wall chart mounted near FACP.

- Complete layout of Fire & Alarm system showing locations of all fire zones, and bells zones.
- Standby battery specification, including ampere-hour capacity Voltage per Cell, number of Cells, and the battery type.
- Operating and maintenance instruction in BLACK colour.
- Emergency instructions in RED colour.
- Name, address & telephone number of the servicing contractor.

The characters of written instructions shall be minimum 6 mm high.

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

## **3.0 APPLICABLE STANDARDS/CODES**

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

- |          |   |                                  |
|----------|---|----------------------------------|
| NFPA 72  | - | National Fire Alarm Code /BS5839 |
| NFPA 101 | - | Life Safety Code                 |

Each and all items of the Fire Alarm System shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by underwriters laboratories (UL) & shall bear the UL label / LPBC approved. or British.

## **4.0 MATERIAL**

### **4.1 Addressable Fire Alarm Control Panel**

The main FACP shall perform the following functions:

- 4.1.1 Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.
- 4.1.2 Supervise all initiating signaling and notification circuits throughout the facility by way of connection to addressable monitor and control modules.
- 4.1.3 Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed.
- 4.1.4 Visually and audibly annunciate any trouble, supervisory, alarm condition on panel display and annunciators.
  - a. When a fire alarm condition is detected and reported initiating devices or appliances, the following functions shall immediately occur:
    - i. The system alarm LED shall flash.
    - ii. A local audible device in the control panel shall sound a distinctive signal.
    - iii. The backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
    - iv. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
    - v. All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated outputs (alarm notification appliances and/or relays) shall be activated.

- b. When a trouble condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
  - i. The system trouble LED shall flash.
  - ii. A local audible device in the control panel shall sound a distinctive signal.
  - iii. The backlit LCD display shall indicate all information associated with the trouble condition, including the type of trouble point and its location within the protected premises.
  - iv. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
  - v. All system outputs assigned via preprogrammed equations for a particular point in trouble shall be executed, and the associated outputs (trouble notification appliances and/or relays) shall be activated.
- c. When a supervisory condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
  - i. The system trouble LED shall flash.
  - ii. A local audible device in the control panel shall sound a distinctive signal.
  - iii. The backlit LCD display shall indicate all information associated with the supervisory condition, including the type of trouble point and its location within the protected premises.
  - iv. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
  - v. All system outputs assigned via preprogrammed equations for a particular point in trouble shall be executed, and the associated outputs (notification appliances and/or relays) shall be activated.

- d. When a pre-alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
  - i. The system pre-alarm LED shall flash.
  - ii. A local audible device in the control panel shall sound a distinctive signal.
  - iii. The backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
  - iv. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
  - v. All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated outputs (alarm notification appliances and/or relays) shall be activated.

#### 4.1.5 Acknowledge Switch

- a. Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from flashing mode to steady-ON mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the LCD display to the next alarm or trouble condition. In addition, the FACP shall support Block Acknowledge to allow multiple trouble conditions to be acknowledged with a single depression of this switch.
- b. Depression of the Acknowledge switch shall also silence all remote annunciator sounders.

#### 4.1.6 Signal Silence Switch

Depression of the Signal Silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition. The selection of notification circuits and relays that are silence able by this switch shall be fully field programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto-silence timers.

- a. Drill Switch

Depression of the Drill switch shall activate all programmed notification appliance circuits. The drill function shall latch until the panel is silenced or reset.

b. System Reset Switch

Depression of the System Reset switch shall cause all electronically latched initiating devices to return to their normal condition. Initiating devices shall re-report if active. Active notification appliance circuits shall not silence upon Reset. Systems that de-activate and subsequently re-activate notification appliance circuits shall not be considered equal. All programmed Control-By-Event equations shall be re-evaluated after the reset sequence is complete if the initiating condition has cleared. Non-latching trouble conditions shall not clear and re-report upon reset.

c. Lamp Test

The Lamp Test switch shall activate all local system LEDs, light each segment of the liquid crystal display and display the panel software revision for service personal.

d. Scroll Display Keys

There shall be Scroll Display keys for FIRE ALARM, SECURITY, SUPERVISORY, TROUBLE, and OTHER EVENTS. Depression of the Scroll Display key shall display the next event in the selected queue allowing the operator to view events by type.

e. Print Screen

Depression of the PRINT SCREEN switch shall send the information currently displayed on the display to the printer.

#### 4.1.7 System Capacity and General Operation

- a. The control panel shall be capable of expansion. Each module loop shall support minimum 127 analog / addressable devices.
- b. The Fire Alarm Control Panel shall include a full featured operator interface control and annunciation panel that shall include a backlit liquid crystal display, individual, color coded system status LEDs, and a QWERTY style alphanumeric keypad for the field programming and control of the fire alarm system. Said LCD shall also support graphic bit maps capable of displaying the company name and logo of either the owner or installing company.

- c. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel.
- d. The FACP shall be able to provide the following software and hardware features:
  - i. Pre-signal and Positive Alarm Sequence: The system shall provide means to cause alarm signals to only sound in specific areas with a delay of the alarm from 60 to up to 180 seconds after start of alarm processing. In addition, a Positive Alarm Sequence selection shall be available that allows a 15-second time period for acknowledging an alarm signal from a fire detection/initiating device. If the alarm is not acknowledged within 15 seconds, all local and remote outputs shall automatically activate immediately.
  - ii. Action: If programmed for action, and the detector reaches a level exceeding the pre-programmed level, the control panel shall indicate an action condition. Sounders bases installed with either heat or smoke detectors shall automatically activate on action Pre-Alarm level, with general evacuation on alarm level.
  - iii. The system shall support a detector response time to meet annunciation requirements of less than 3 seconds.
  - iv. NFPA 72 Smoke Detector Sensitivity Test: The system shall provide an automatic smoke detector test function that meets the requirements of NFPA 72.
  - v. On-line or Off-line programming: The system shall provide means to allow panel programming either through an off-line software utility program away from the panel or while connected and on-line. The system shall also support upload and download of programmed database and panel executive system program to a Personal Computer/laptop.

- vi. History Events: The panel shall maintain a history file of the events, each with a time and date stamp. History events shall include all alarms, troubles, operator actions, and programming entries. The control panels shall maintain a 1000 event Alarm History.
- vii. Drill the system shall support means to activate all silenceable fire output circuits in the event of a practice evacuation or "drill". If enabled for local control, the front panel switch shall be held for a minimum of 2 seconds prior to activating the drill function
- viii. Passwords and Users: The system shall support two password levels, master and user. Minimum 4 user passwords shall be available, each of which may be assigned access to the programming change menus, the alter status menus, or both. Only the master password shall allow access to password change screens.
- ix. Environmental Drift Control: The system shall provide means for setting Environmental Drift Compensation by device. When a detector accumulates dust in the chamber and reaches an unacceptable level but yet still below the allowed limit, the control panel shall indicate a maintenance alert warning. When the detector accumulates dust in the chamber above the allowed limit, the control panel shall indicate a maintenance urgent warning.
- x. Custom Action Messages: The system shall provide means to enter custom action messages of characters each.
- xi. Print Functions: The system shall provide means to obtain a variety of reports listing all event, alarm, trouble. Additional reports shall be available for point activation for the last Walk Test performed, detector maintenance report containing the detector maintenance status of each installed addressable detector, all panel settings including broad cast time, event ordering, and panel timer values for Auto Silence, Silence Inhibit, supervision settings for power supply and printers, all programmed logic equations, all custom action messages, all non-fire



and output activations (if pre-programmed for logging) all active points filtered by alarms only, troubles only, supervisory alarms, pre-alarms, disabled points and activated points, all installed points filtered by SLC points, panel circuits, logic zones, annunciators, releasing zones, spal zones, and trouble zones.

- xii. One-Man Walk Test: The system shall provide both a basic and advanced walk test for testing the entire fire alarm system. The basic walk test shall allow a single operator to run audible tests on the panel. All logic equation automation shall be suspended during the test and while annunciators can be enabled for the test, all shall default to the disabled state.
- xiii. The system shall support general purpose software zones for linking inputs to outputs. When an input device activates, any general zone programmed into that device's zone map will be active and any output device that has an active general zone in its map will be active. It shall also be possible to use general zone as arguments in logic equations.
- xiv. 1000 Logic Equations: The system shall support logic equations for AND, OR, NOT, ONLY1, ANYX, XZONE or RANGE operators that allow conditional I/O linking. When any logic equation becomes true, all output points mapped to the logic zone shall activate.
- xv. Alarm Verification, by device, with timer and tally: The system shall provide a user-defined global software timer function that can be set for a specific detector or indicating panel module input. The timer function shall delay an alarm signal for a user-specified time period and the control panel shall ignore the alarm verification timer if another alarm is detected during the verification period. It shall also be possible to set a maximum verification count between 0 and 20 with the "0" setting producing no alarm verification. When the counter exceeds the threshold value entered, a trouble shall be generated to the panel.

#### 4.1.8 Loop (Signaling Line Circuit) Control Module

- a. The Loop Control Module shall monitor and control 127 devices.
- b. The Loop Control Module shall contain its own microprocessor and shall be capable of operating in a local/degrade mode (any addressable device input shall be capable of activating any or all addressable device outputs) in the unlikely event of a failure in the main CPU.
- c. The Loop Control Module shall provide power and communicate with all intelligent addressable detectors and modules on a single pair of wires. This SLC Loop shall be capable of operating as a NFPA Style 4 (Class B) circuit.
- d. The SLC interface board shall receive analog or digital information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular device. Each SLC Loop shall be isolated and equipped to annunciate an Earth Fault condition. The SLC interface board software shall include software to automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information may also be used for automatic detector testing and the automatic determination of detector maintenance requirements.

#### 4.1.9 Enclosures

- a. The control panel shall be housed in a UL-listed cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.
- b. The back box and door shall be constructed of 0.060 steel with provisions for electrical conduit connections into the sides and top.

- c. The door shall provide a key lock and include a transparent opening for viewing all indicators. For convenience, the door shall have the ability to be hinged on either the right or left-hand side.
- d. The control unit shall be modular in structure for ease of installation, maintenance, and future expansion.

#### 4.1.10 Power Supply

- a. The Addressable Main Power Supply shall operate on 230 VAC, 50 Hz, and shall provide all necessary power for the FACP.
- b. The Addressable Main Power Supply shall provide a battery charger for 4 hours of standby using dual-rate charging techniques for fast battery recharge. The supply shall be capable of charging batteries within a 48-hour period.
- c. The Addressable Main Power Supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.
- d. The Addressable Main Power Supply shall be power-limited per 1995 UL864 requirements.

#### 4.1.11 Printer

- a. Printers shall be of the automatic type, printing code, time, date, location, category, and condition.
- b. The printer shall provide hard-copy printout of all changes in status of the system and shall time-stamp such printouts with the current time-of-day and date. The printer shall be standard carriage with 80-characters per line and shall use standard pin-feed paper. The printer shall be enclosed in a separate cabinet suitable for placement on a desktop or table and UL, ULC listed for use with the NFS-3030. The printer shall communicate with the control using an interface complying with Electrical Industries Association standard EIA-232D.
- c. Thermal printers are not acceptable.
- d. The system shall have a strip printer capable of being mounted directly in the main FRCP enclosure. Alarms shall be printed in easy-to-read RED, other messages, such as

a trouble, shall be printed in BLACK. This printer shall receive power from the system power supply and shall operate via battery back up if AC mains are lost. The strip printer shall be UL 864 listed.

#### 4.1.12 Field Programming

- a. The system shall be programmable, configurable and expandable in the field without the need for special tools, laptop computers, or other electronic interface equipment. There shall be no firmware changes required to field modify the system time, point information, equations, or annunciator programming/information.
- b. It shall be possible to program through the standard FACP keyboard all system functions.
- c. All field defined programs shall be stored in non-volatile memory.
- d. Two levels of password protection shall be provided in addition to a key-lock cabinet. One level shall be used for status level changes such as point/zone disable or manual on/off commands (Building Manager). A second (higher-level) shall be used for actual change of the life safety program (installer). These passwords shall be five (5) digits at a minimum. Upon entry of an invalid password for the third time within a one minute time period an encrypted number shall be displayed. This number can be used as a reference for determining a forgotten password.
- e. The system programming shall be "backed" up on a 3.5" floppy diskette utilizing an upload/download program. This system back-up disk shall be completed and given in duplicate to the building owner and/or operator upon completion of the final inspection. The program that performs this function shall be "non-proprietary", in that, it shall be possible to forward it to the building owner/operator upon his or her request.

#### 4.2 Notification Appliances

- 4.2.1 Electronic sounders shall operate on 24 VDC nominal.
- 4.2.2 Electronic sounders shall be field programmable without the use of special tools, at a sound level of at least 90 dBA measured at 10 feet from the device.

- 4.2.3 Shall be flush or surface mounted as shown on plans.
- 4.2.4 Visual alarm device shall meet the requirements of the ADA, UL Standard 1971, be fully synchronized, and shall meet the following criteria:
  - a. The maximum pulse duration shall be of one second.
  - b. Strobe intensity shall meet the requirements of UL 1971.
  - c. The flash rate shall meet the requirements of UL 1971.
- 4.2.5 Audible Visual Combination Devices
  - a. Shall meet the applicable requirements of Section A listed above for audibility.
  - b. Shall meet the requirements of Section B listed above for visibility.

#### 4.3 **Addressable Devices - General**

- 4.3.1 Addressable devices shall provide an address-setting means using rotary decimal switches.
- 4.3.2 Addressable devices shall use simple to install and maintain decade (numbered 0 to 9) type address switches.
- 4.3.3 Detectors shall be Analog and Addressable, and shall connect to the fire alarm control panel's Signaling Line Circuits.
- 4.3.4 Addressable smoke and thermal detectors shall provide dual (2) status LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the flashing mode operation of the detector LEDs can be programmed off via the fire control panel program.
- 4.3.5 The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. Sensitivity can be automatically adjusted by the panel on a time-of-day basis.
- 4.3.6 Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.
- 4.3.7 The detectors shall be ceiling-mount and shall include a separate twist-lock base, which includes a tamper proof feature.
- 4.3.8 The following bases and auxiliary functions shall be available:

- a. Sounder base rated at 85 DBA minimum.
  - b. Form-C Relay base rated 30VDC, 2.OA
  - c. Isolator base
- 4.3.9 The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
- 4.3.10 Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (PHOTO, THERMAL).
- 4.3.11 Addressable Pull Box (manual station)
- a. Addressable pull boxes shall, on command from the control panel, send data to the panel representing the state of the, manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
  - b. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
  - c. Manual stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44 mm) or larger.
- 4.3.12 Intelligent Photoelectric Smoke Detector
- a. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
- 4.3.13 Intelligent Heat Detectors
- a. Heat detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a '-rate-of-rise element rated' at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.
- 4.3.14 Intelligent Duct Smoke Detector
- a. The smoke detector housing shall accommodate either an intelligent ionization detector or an intelligent photoelectric

detector, of that provides continuous analog monitoring and alarm verification from the panel.

- b. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.

#### 4.3.15 Addressable Monitor Module

- a. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs.
- b. The monitor module shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box.
- c. The IDC zone shall be suitable for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
- d. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch (70 mm) x 1-1/4 inch (31.7 mm) x 1/2 inch (12.7 mm). This version need not include Style D or an LED.

#### 4.3.16 Addressable Control Module

- a. Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24VDC powered, polarized audio/visual notification appliances. For fan shutdown and, other auxiliary control functions, the control module may be set to operate as a dry contract relay.
- b. The control module shall mount in a standard 4-inch square (101.6 mm square), 2 1/8 inch (54 mm) deep electrical box, or to a surface mounted back box.
- c. The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive AN signal, or 2 amps of resistive AN signal operation, or as a dry contact (Form-C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure

that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.

- d. Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised, UL listed remote power supply.
- e. The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.

#### 4.3.17 Isolator Module

- a. Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of W47S Updated Fire Alarm specifications modules or detectors that may be rendered inoperative by short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the building.
- b. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.
- c. The isolator module shall not require any address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
- d. The isolator module shall mount in a standard 4-inch (101.6 mm) deep electrical box or in a surface mounted back box. It shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

#### 4.3.18 Addressable Repeater Panel:

- a. The alphanumeric display repeater panel shall be a supervised, back-lit LCD display containing a minimum of 160 characters for alarm annunciation in clear English text.
- b. The LCD repeater panel shall display all alarm and trouble conditions in the system.
- c. Up to 32 LCD repeater panel may be connected to an EIA 485 interface. LCD repeater panel shall not reduce the



annunciation or point capacity of the system. Each LCD shall include vital system wide functions such as, System Acknowledge, Silence and Reset.

- d. LCD display repeater panel shall mimic the main control panel 80 character display and shall not require special programming.
- e. The LCD repeater panel shall have switches, which may be programmed for System control such as, Global Acknowledge, Global Signal Silence and Global System Reset. These switch inputs shall be capable of being disabled permanently or by a key lockout function on the front plate.

#### **4.4 Batteries and External Charger**

##### **4.4.1 Battery**

- a. Shall be 12 volt, Gell-Cell type.
- b. Battery shall have sufficient capacity to power the fire alarm system for not less than twenty-four hours plus 5 minutes of alarm upon a normal AC power failure.
- c. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks refilling, spills and leakage shall not be required.

##### **4.4.2 External Battery Charger:**

- a. Shall be completely automatic, with constant potential charger maintaining the battery fully charged under all service conditions. Charger shall operate from a 120/240-volt 50/60 hertz source.
- b. Shall be rated for fully charging a completely discharged battery within 48 hours while simultaneously supplying any loads connected to the battery.
- c. Shall have protection to prevent discharge through the charger.
- d. Shall have protection for overloads and short circuits on both AC and DC sides.

#### **4.5 Wiring and Cabling**

Wiring and cabling of Fire and alarm system shall be carried out in conduits. 1.5 mm<sup>2</sup> fire resistant cable with LSZH outer sheath shall be provided for the fire alarm system. The cable shall be work for 120 minutes in fire condition.

All wires and cables shall be color-coded, tagged and checked for open, short or ground faults. No transposition of colors will be permitted. All wiring shall be made on terminal blocks of proper size and type for the services involved. Cable joints shall only be allowed on the detector bases.

## **5.0 INSTALLATION**

### **5.1 Fire Alarm System Equipment**

The installation of Fire Alarm system equipment shall be in strict accordance with the manufacturer's instructions / recommendations and these specifications.

The testing of Fire Alarm equipment shall be in compliance with the relevant standards and regulations. During testing of equipment, emphasis shall be laid on the following:

- Operational Safety
- Regular functioning of the system and devices
- Protection against false alarms

Various detectors like smoke, heat, manual call point etc. shall be subjected to the basic tests and sensitivity tests. The automatic detectors shall be tested in various ways to check real and false alarm behaviours.

### **5.2 Wiring and Cabling**

Wiring and cabling of fire alarm system shall be carried out as per instructions given in Section 8212 'Low Tension Cables' of these specifications.

## **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.

The training session shall include but not limited to the following:

- 6.1 Detailed explanation of wall charts as mentioned in Article 2.0 of this section.
- 6.2 Function of each control switch
- 6.3 Periodic operational testing of panel/devices.

- 6.4 Maintenance of fire log book supplied by manufacturer.
- 6.5 Actions to be taken upon receiving following signals:
  - 6.5.1 False alarm indication
  - 6.5.2 Trouble on any initiating or indicating zone
  - 6.5.3 Common alarm or common trouble indication
  - 6.5.4 Low battery voltage indication
- 6.6 Field modifiable programming.

## **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 Automatic Detectors and Manual Station**

#### **7.2.1 Measurement:**

Measurement shall be made for the total number of each type of automatic detectors and manual call points acceptably supplied and installed by the Contractor as complete unit.

#### **7.2.2 Payment:**

Payment shall be made for the number of units measured as provided above at the contract unit price and shall constitute full compensation for supplying, installing, testing and commissioning of each type of the automatic detectors with base and manual call points including mounting accessories.

### **7.3 Sounder**

#### **7.3.1 Measurement:**

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

#### **7.3.2 Payment:**

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

compensation for supplying, installing, testing and commissioning of all the Sounder including all mounting accessories like outlet boxes etc.

#### **7.4 Fire Alarm Control Panel**

##### **7.4.1 Measurement:**

Measurement shall be made for fire alarm control panel including all related equipment as given in BOQ such as power supply, relays, batteries, etc. alongwith all accessories acceptably supplied and installed by the Contractor as complete unit.

##### **7.4.2 Payment:**

Payment shall be made for the complete unit measured as provided above at the contract unit price and shall constitute full compensation for supplying, installing, testing and commissioning of fire alarm control panel alongwith all accessories.

#### **7.5 Wiring of Fire Alarm Loops**

##### **7.5.1 Measurement:**

Measurement shall be made for the total number of wiring of fire alarm loops and the required number of junction boxes acceptably supplied and installed by the Contractor.

##### **7.5.2 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 fire alarm loops wiring including junction boxes and all accessories.

\*\*\* End of Section 8331 \*\*\*

## **SECTION - 8335**

### **CLOSED CIRCUIT TELEVISION SYSTEM (CCTV)**

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

## **1.0 SCOPE OF WORK**

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

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

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

## **2.0 GENERAL**

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

System shall have provision of WAN connectivity for remote monitoring.

### **3.0 APPLICABLE STANDARDS AND CODES**

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

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



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

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

## 4.0 EQUIPMENT

### 4.1 Fixed Colour Dome/Box Camera Varifocal

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

### 4.2 Colour Video Dome Camera with PTZ

Colour video dome camera with PTZ shall have following technical:

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

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

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

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

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

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

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

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

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

#### 4.4 **Workstation**

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

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

#### 4.5 **NVR/Camera/Database Server**

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

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

#### 4.6 Camera Housing & Mount

The camera mount should be:

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

#### 4.7 Speed Dome Controller / PTZ Controller

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

#### 4.8 Cables

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

#### 4.9 LCD Display

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

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

## 5.0 VIDEO SURVEILLANCE APPLICATION SOFTWARE

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

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

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

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

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

There must be a single encoder for each camera.

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

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

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

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

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

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

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

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

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

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

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

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

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

## **6.0 INSTALLATION**

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

## **7.0 TRAINING**

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

## **8.0 MEASUREMENT AND PAYMENT**

### **8.1 General**

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

### **8.2 Cameras / Lenses and Displays**

#### **8.2.1 Measurement:**

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

#### **8.2.2 Payment:**

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

### **8.3 NVR / Controller**

#### **8.3.1 Measurement:**

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

#### **8.3.2 Payment:**

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



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

#### **8.4 Cable/Conduit**

##### **8.4.1 Measurement:**

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

##### **8.4.2 Payment:**

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

#### **8.5 Operator Console**

##### **8.5.1 Measurement:**

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

##### **8.5.2 Payment:**

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

\*\*\* End of Section 8335 \*\*\*

## **SECTION – 8341**

### **PUBLIC ADDRESS SYSTEM**

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

## **1.0 SCOPE OF WORK**

The work under this section consists of supplying, installing, testing and commissioning of all material and services 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° 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 wiring 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**
- 2. APPLICABLE STANDARDS**
- 3. SUBMITTALS AND SHOP DRAWINGS**
- 4. MATERIAL AND EQUIPMENT**
- 5. EXECUTION**
- 6. TESTING AND COMMISSIONING**
- 7. MEASUREMENT AND PAYMENT**

## 1. SCOPE

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

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

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

## 2. APPLICABLE STANDARDS

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

## 3. SUBMITTALS & SHOP DRAWINGS

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

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

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

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

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

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

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

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

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

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

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

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

#### **4. MATERIAL & EQUIPMENT**

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

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

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

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

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

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

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

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

#### 4.2 POLYPROPYLENE RANDOM (PPR) PIPES AND FITTINGS

Polypropylene Random Pipes and fittings shall conform to the following standard

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

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

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

Cast iron pipes shall be centrifugally (SPUN) cast.

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

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

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

##### UPVC Pipes

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

##### PIPES

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

##### FITTINGS

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

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

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

##### RUBBER RINGS

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

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

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

#### 4.4 PLUMBING FIXTURES

##### 4.4.1 General Requirements

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

All fixtures shall be of the best quality and finish.

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

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

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

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

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

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

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

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

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

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

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

#### 4.4.2 Wash Basins

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

#### 4.4.3 Vanity Wash Basins & laboratory sink

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

#### 4.4.4 Water Closets (European type)

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

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

#### 4.4.5 Water Closets (Orissa)

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

#### 4.4.6 Kitchen Sinks

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

#### 4.4.7 Shower Tray

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

#### 4.4.8 Shower Head

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

#### 4.4.9 Bathtub

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

#### 4.4.10 Urinals

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



## 4.5 MISCELLANEOUS ITEMS

### 4.5.1 Taps and Cocks

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

### 4.5.2 Floor traps/drains

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

### 4.5.3 Roof Drains

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

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

### 4.5.4 Cleanouts

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

#### 4.5.5 Grease Trap/Interceptor

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

or

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

#### 4.5.6 Glass Mirror

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

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

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

#### 4.5.8 Gully Trap

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

#### 4.5.9 Cast Iron Grating

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

#### 4.5.10 Electric Water Cooler

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

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

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

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

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

#### 4.5.11 WATER FILTERS

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

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

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

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

#### 4.5.12 Gas or Electric Water Heaters

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

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

Heater shall be provided with following accessories.

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

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

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

Standard type gas water heaters shall have following specs:

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

## **5. EXECUTION**

### **5.1 GENERAL**

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

\*Horizontal to vertical : quarter bend or short turn.

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

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

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

Each length of pipe & each pipe fitting, trap, fixture, & device used in a plumbing system shall have cast, stamped or indelibly marked on it the maker's mark or name, the weight, type & classes of the product, when such marking is required by the approved standard that applies.

Where different sizes of pipes, or pipes and fittings are to be connected, the proper size increasers or reducers or reduced fittings shall be used between the two sizes.

Any fitting or connection which has an enlargement, chamber, or recess with a ledge, shoulder, or reduction of pipe area that offers an obstruction to flow through the drain pipe is prohibited. The vertical distance from the fixture outlet to the trap weir shall not exceed 600 mm. Each fixture trap shall have a water seal of not less than 50 mm and not more than 100 mm.

Full S, bell, crown vented traps and traps/depending for their seal upon the action of movable parts are prohibited. No fixture shall be double trapped. Where fixture comes in contact with wall and floors, the joint shall be water-tight. Piping in ground shall be laid on a firm bed for its entire length.

Piping in the plumbing system shall be installed without undue strains and stresses. Vertical piping shall be securely held to keep the pipe in alignment and carry the weight of the pipe and contents. Horizontal piping shall be supported to keep it in alignment and prevent sagging. Hangers and anchors shall be of metal of sufficient strength to maintain their proportional share of pipe alignments and prevent rattling. Hangers and anchors shall be securely attached to the building under construction. It must be clearly understood that the Contractor shall be

fully responsible for hangers and supports and shall obtain prior approval of design as to the shape, material, dimensions, spacing etc.

Piping in concrete or masonry walls or footings shall be placed or installed in sleeves which will permit access to the piping for repair or replacement.

## 5.2 G.I. COLD, HOT WATER PIPES AND FITTINGS

The run and arrangement of all pipes shall be as shown on the Drawings and as directed during installation. All vertical pipes shall be erected plumb and shall be parallel to wall and other pipes. All horizontal runs of piping shall be kept close to walls. If required to change the location etc. during the currency of the work, the Contractor will do so at no additional cost. Screwed joints in G.I. pipes shall be made perfectly tight, without the use of any filler except approved jointing compound or tape. Wherever required to make flanged joints, they shall conform to BS 10 Table D.

Furnish and install all pipe passing through floors and walls with sleeves of G.I. sheet, 18 gauge, the inside dia. of which shall be at least 1/2" greater than the outside dia of the pipe passing through it. Sleeves in exterior walls and pits shall have anchor flanges and space between pipe and sleeve shall be caulked and sealed watertight. At waterproof locations, an approved water-proof type pipe sleeve shall be provided.

All embedded water supply piping shall be wrapped with approved anti-corrosion polyethylene tape. All exposed piping shall be painted with two coats of enamel paint over a coat of red oxide.

Pipes laid in trenches (external) shall be protected by applying coating of primer grade 10/20 bitumin+hyacinth cloth mopped with bitumen (50% grade 80/100 & 50% grade 10/20).

### Insulation

All hot water supply and return piping shall be insulated as specified herein. Prior to insulation the pipes shall be hydraulically tested and cleaned.

<b>Nominal Pipe Dia. (mm)</b>	<b>Thickness of per-form Fiber glass pipe insulation. (mm)</b>
15 (1/2")	25
20 (3/4")	25
25 ( 1" )	25
32 (1-1/4")	25
40 (1-1/2")	25
50 ( 2" )	25
65 (2-1/2")	25
75 ( 3" )	25

Insulation shall consist of pre-formed fiberglass pipe insulation, with factory applied reinforced aluminum vapor barrier, single layer in semi-circular halves, consisting of long, fine glass fibers, bonded with a temperature resistant binder, free from shot or coarse fibers, damage resistant, light in weight, easy to handle, cut and fit. The product shall comply with the requirements of B.S. 3958: Part 4. The insulation shall be rotproof, odorless, non-hygroscopic, and shall not sustain vermin. The fiberglass insulation shall be covered with a layer of approved polyethylene tape in the field. Further reinforcement shall be provided by the use of 20 mm wide soft aluminum bands, generally spaced at 457

mm and on either side of elbows and tees. All butt joints shall be sealed with self-adhesive type of approved quality adhesive tape.

All trimmed sections shall be secured by wrapping of approved type of self adhesive tape to form a complete waterproof seal. All work shall be done in a neat and workmanlike manner, and should reflect recommended practice.

All Hot water and Hot water return lines concealed in walls only, shall be provided with Glass wool blanket insulation.

#### Pipe work Supports

All supports, clips, steel rods and hangers shall be of mild steel painted with two coats of approved metallic zinc primer. All clips and brackets shall be equipped with 9 mm sectional rubber liners (shore-hardness A 40+5°).

Pipe work supports shall be installed in order to allow free movement due to expansions and contraction. Supports shall be arranged adjacent to joints, changes of direction and branches. Each support shall carry the overall weight of pipework and water to be borne by it. The intervals between pipe supports shall not exceed the following :

Maximum interval between supports (metres)		
Nominal Dia mm	Steel pipes	
	Horizontal	Vertical
10	1.7	1.7
15	2.0	2.0
20	2.4	2.4
25	2.7	2.7
32	2.7	2.7
40	3.0	3.5
50	3.4	3.9
65	3.7	4.3
80	3.7	4.3
100	4.1	4.6

Dimensions of Support Materials			
Nominal Dia mm	Flat iron bands mm	Support rods mm	U-bolts mm
10	25 x 3	6	6
15	25 x 3	6	6
20	25 x 3	6	6
25	25 x 3	6	6
32	40 x 5	10	10
40	40 x 5	10	10
50	40 x 5	10	10
65	50 x 6	12	12
80	50 x 6	12	12
100	50 x 6	12	12

Single pipes hung from floor slabs shall be supported on rod hangers. Where two or more pipes are involved a channel or angle iron shall be fitted to the underside of slab by two hangers and the pipes shall be supported from the channel iron by rod hangers and flat iron bands.

All hanger rods shall have double nuts and beveled washers to allow the hanger rod to swing.

Multiple pipe runs along walls shall be supported on purpose made substantial angle and channel frames securely fixed to the wall, floor and ceiling as necessary. All pipes shall be arranged to slide on the steel supports and U-bolts shall be provided to form a rigid guide.

Exposed pipe work shall be supported on channel, angle iron or with U-bolts to form a rigid guide.

All U-bolts, except used as anchors, shall have a pair of nut and washers on each leg with the supporting steel flange clamped tight between the pair of nuts to form a rigid guide and allowing the pipe to slide axially. U-bolts shall be provided on alternate pipe bracket.

Small pipe work running along skirting shall be supported by standard built-in or screw-on type clips.

Pipes shall be individually supported. Pipes shall not hung from other pipes.

Points at which pipes pass through walls, floors, connections to plant, equipment and heat emitters, etc. do not constitute points of supports for the pipes.

Vertical pipes shall be supported at the base or at anchor points to withstand the total weight of the riser. Brackets from risers shall not be used as a means-of support for the riser.

Vibration isolators to be provided with the hangers as approved by the Engineer.

## 5.3 POLYPROPYLENE RANDOM PIPES & Jointing

### 5.3.1 Jointing Techniques

The surfaces of the pipes and fittings must be clean and without impurities. Pipe ends must be clean, cut at right angles. It is recommended to cut 1cm from the pipe ends in order to prevent possible micro-cracking due to incautious handling. Before carrying out the welding, check that the poly-fusion device operates correctly and that it reaches the required welding temperature ( $260^{\circ}\text{C} \pm 5$ ).

Jointing is done by heat fusion (welding) by means of welding machine. Welding is carried out by means of heating simultaneously the male and female parts to be joined together, once the welding temperature is reached the joint is made and held for cooling time. (see table I below )

### 5.3.2 Welding Instructions using socket welding machine

- i. Check whether the welding tool corresponds to the size you need to join.



- ii. The welding tool/device has reached the necessary operating temperature of 260°C  $\pm$ 10
- iii. Cut the pipe at right angles to the pipe axis by using cutter or a hack saw.
- iv. Clean the pipe from burrs, cutting and chips
- v. Mark the welding depths at the end of 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

<b>Est. Diameter (mm)</b>	<b>Welding Depth (mm)</b>	<b>Heating Time DVS 2207* (sc).</b>		<b>Heating time (sc.)</b>	<b>Cooling Time (min.)</b>
20	14.0	5	8	4	2
25	15.0	7	11	4	2
32	16.5	8	12	6	4
40	18.0	12	18	6	4
50	20.0	18	27	6	4
63	24.0	24	36	8	6

The heating time have to be increased 50% if average temperature is under + 5°C

### 5.3.3 Welding of PPR Pipes

- i. Cutting of pipe at right angle with a cutter.
- ii. Marking of welding depth on the pipe end.
- iii. Simultaneous heating of both pipe and fittings according to required heating time (as per given data).
- iv. Pushing of pipe end into the fitting and alignment of the assembly within specified time period
- v. Finish joint.

### 5.3.4 Installation Principles

#### 5.3.4.1 Fastening technique for open installation

The selection of fastening material and its application have to be determined as:-

- 1.Fixed Point
- 2.Sliding Point

Pipe clamps are such as to meet all requirements and ensure that no mechanical damage on the pipe surface can occur.

#### 5.3.4.2 Fixed Point

Valves and connections resisting to bending stresses have to be fastened by means of points. In particular cases the fixed points are to be positioned closed to branches or wall passages. The axial expansion will be compensated between two points. To assess the resistance of the fixed points one has to take into account the stresses to which they will be subjected, caused by linear expansion, weight of the piping and weight of the transportation fluid. Fixed points should be delimited on both sides of the clamp, avoiding oneself of the rim fittings or valves.

#### 5.3.4.3 Sliding Point

The sliding points must keep the system aligned and support it, and allow the axial sliding of the piping as well. The sliding are to be firmly mounted in order to prevent vibration and transmission of noise.

Distance between the support points in cm.

<b>Pipe diameter</b>	<b>Temperature in °C</b>		
	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° degrees unless otherwise recommended by the manufacturer. If the alignment requires deflections in excess of the specified limitations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set forth, as approved.

#### 5.4.5 PLACING AND LAYING

Pipe and accessories shall be carefully lowered into the trench by means of derrick ropes, belt slings, or other suitable equipment. Under no circumstances shall any of the water line materials be dropped or dumped into the trench. Care shall be taken to avoid abrasion of the pipe coating. Poles used as levers shall be of wood and shall have broad flat faces to prevent damage to the pipe. Except where necessary in making connections with other lines or authorized by the Engineer pipe shall be laid with the bells facing in the direction of laying. The full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate bell coupling and joints. Pipe that has the grade or the joint disturbed after laying shall be taken out and re-laid. Pipe shall not be laid in water shall be kept out of the trench until the materials in the joints have hardened or until caulking or jointing is completed. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no trench water, earth, or other substances will enter the pipes or fittings. Where any part of a coating or lining is damaged, the repair shall be made by the Contractor at his expense in a satisfactory manner. Pipes shall be installed in accordance with recommendations of the pipe manufacturer. Pipe ends left for future connections shall be valved, plugged or capped, and anchored, as shown or as directed, where connections shall be made by using specials and fittings to suit the actual conditions.

#### 5.4.6 JOINTING

The joints shall be in accordance with the recommendations of the manufacturer or as approved by the Engineer.

Connections between different types of pipes and accessories shall be made with transition fittings where recommended by the pipe manufacturer.

Service connections shall be made as indicated and in accordance with the recommendations of the pipe manufacturer.

#### 5.4.7 THRUST BLOCKS

Plugs, caps, tees, bends and fire hydrants shall be provided with concrete thrust blocks. Backing shall be placed between solid ground and the hydrant or fitting to be anchored. The area of bearing shall be as

shown on the Drawing. The backing shall be so placed that fitting joints shall be accessible for repair. The concrete shall be class C plain cement concrete.

#### 5.4.8 PIPE BEDDING

Fine sand as pipe bedding material shall be used for bedding of pipes and fittings. The sand shall be free from clay, silt, salts, organic impurities and debris. Approval of pipe bedding materials shall be obtained by the site Engineer prior to placing.

#### 5.4.9 FLUSHING

The Contractor shall provide facilities for flushing the line. Water for flushing the line shall be arranged by the Contractor. Flushing of line shall be done section by section. For each valved section of pipeline the Contractor shall make a temporary hose connection between the water pipeline and the pipeline under test. Water shall be pumped into the section flushed. Other arrangements for storing and pumping of water shall be subject to the approval of Engineer. Due precautions shall be taken by the Contractor for the disposal of water. The pipeline shall be flushed by keeping all the branching pipes open. Flushing shall be continued until clean water starts flowing through the other end. Section by section, the entire pipeline shall be flushed at a minimum flushing velocity of 2.5 ft./sec.

#### 5.4.10 PIPELINE DISINFECTION

The Contractor shall furnish all equipment, labour and material for the proper disinfection of the pipeline. Disinfection shall be accomplished by chlorination after the lines have been tested for leakage but before they have been connected to the main system. Disinfections of the pipelines shall be done in the presence of the Engineer's representative with equipment approved by him.

- **Chlorination** A chlorine and water mixture shall be supplied by means of a solution feed chlorination device. The chlorine solution shall be applied at one end of the pipeline through a trap, in such a manner that as the pipeline is filled with water, the dosage applied to the water entering the pipe shall be 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 be installed in the system shall be provided with approved cowl and will rise at least 0.70 meter above the roof.

Special requirements for uPVC pipes and fittings are as under:

Maximum Interval between Supports (m)  
(Support centers for uPVC pipe work systems)\*

Nominal Diameter, d <sub>e</sub>  (mm)	PIPEWORKS	
	Horizontal (10xd <sub>e</sub> )  (m)	Vertical  (m)
40	0.40	1.2
50	0.50	1.5
75	0.75	2.0
110	1.10	2.0

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

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

All exposed uPVC pipes shall be given two coats of approved colour water based emulsion paint (note that oil based paints must be avoided).

#### PRECAUTIONS

Following points describe how an uPVC must be cared of:

- The depth of concrete cover above uPVC pipe depends on the pipe gradient. However, a minimum of 1 (one) inch concrete cover must be provided.
- When using cemented joints, the adhesive should be given sufficient opportunity to harden before the pipe is concreted in.
- Horizontal lines that are concreted-in should be anchored against upward movement and should be adequately secured while the concrete is being poured.
- During the pouring and setting of concrete, necessary care shall be taken to prevent physical damage to the pipes.
- When using heated concrete or when steaming the concrete, the sensitivity of uPVC material to temperature changes should be borne in mind.
- Concrete mortar that is used before concreting-in shall include no sharp-edged material.
- Avoid excessive misalignment of the pipes.
- Avoid excessive tightness of joints.
- Provide sufficient expansion joints to allow thermal movement or regression.
- Use only allowed cleaning & descaling techniques for different situations & locations (as described in 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**

- 1. SCOPE OF WORK**
- 2. APPLICABLE STANDARDS**
- 3. SUBMITTALS**
- 4. FIRE PROTECTION EQUIPMENTS**
- 5. CLEAN AGENT FIRE EXTINGUISHING SYSTEM**
- 6. PORTABLE FIRE EXTINGUISHERS**
- 7. INSTALLATION AND TESTING OF PIPES**
- 8. MEASUREMENT AND PAYMENT**

## **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<sup>2</sup> and test pressure of 25 kg/cm<sup>2</sup>.

#### 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 properly 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 FIRE SPRINKLERS

The fire sprinklers have K-factor of 5.6. Sprinklers shall be located, spaced and positioned in accordance with the requirements of NFPA-13, as per drawing and/or as per manufacturer's recommendation. Sprinklers shall be positioned to provide protection of the area consistent with the overall objectives of NFPA-13 by controlling the positioning and allowable area of coverage for each sprinkler. The sprinkler shall be FM/UL listed having maximum working pressure 175 psi (12.1 bars) and hydrostatic test pressure of 350psi (25 bars).

#### 4.5 TEMPERATURE RATING, CLASSIFICATIONS, COLOR CODING & PAINTING OF FIRE SPRINKLERS

Sprinklers shall only be painted as per manufacturer's recommendation or as per NFPA Standard.

Maximum Ceiling Temp		Temperature Rating		Temperature Classification	Color Code	Glass Bulb Color
°F	°C	°F	°C			
100	38	135-170	57-77	Ordinary	Uncolored or Black	Orange or Red
150	66	175-225	79-107	Intermediate	White	Yellow or Green
225	107	250-300	121-149	High	Blue	Blue
300	149	325-375	163-191	Extra High	Red	Purple
375	191	400-475	204-246	Very Extra High	Green	Black
475	246	500-575	260-302	Ultra High	Orange	Black
625	329	650	343	Ultra High	Orange	Black

#### **4.6 STOCK OF SPARE SPRINKLERS**

A supply of spare sprinklers shall be maintained on the premises so that any sprinkler that have operated or been damaged in any way can be promptly replaced. The stock of spare sprinklers shall include all types and ratings installed as per NFPA standard and shall be as follows:

- 1) Not less than 06 sprinklers for protected facilities having under 300 sprinklers.
- 2) Not less than 12 sprinklers for protected facilities having 300 -1000 sprinklers.
- 3) Not less than 24 sprinklers for protected facilities having over 1000 sprinklers.

One sprinkler wrench as specified by sprinkler manufacturer shall be provided in the cabinet for each type of sprinkler installed to be used for the removal and installation of sprinklers in the system. A list of sprinklers installed in the property shall be posted in the sprinkler cabinet. The list includes the following:

- Sprinkler identification Number (SIN) if equipped or the manufacturer, model, K-factor, deflector type, thermal sensitivity and pressure rating.
- General description
- Quantity of each type, to be contained in the cabinet
- Issue or revision date of the list.

#### **4.7 FLOOR CONTROL VALVE ASSEMBLY (FCVA)**

The FCVA is provided at every zone of sprinkler network as shown on drawing. This assembly consists of butterfly valve with supervisory switch, pressure reducing valve, pressure gauge, check valve, flow switch with clamping accessories and drain valve. The drain valve is utilized for the flow control, inspection, testing and draining of sections of wet pipe automatic sprinkler system. This system with an integral sight glass assembly provides a simplified means for water flow alarm and draining of feed drains. This drain is provided with shut off valve, dual orifice valve and sight glass assembly. All sprinkler pipe and fittings shall be installed so that the system can be drained.

#### **4.8 ALARM CHECK VALVES**

Alarm check valves shall be equipped to give clear positive audible alarm at any water flow through the sprinkler system equal to or greater than that from a single automatic sprinkler. It shall be suitable for vertical/horizontal installations as per system requirement or as directed by the Engineer and for the variable pressure of water supply.

Alarm check valves shall be of flanged type designed to withstand up to working pressure of 250 psi. It shall have cast iron body and clapper hinge, bronze clapper assembly, pilot valve assembly and other moving parts.

The alarm check valve assembly shall consist of the following:

- Alarm checks Valve, with trimmings for variable pressure, open drain, Vertical installation.
- Ø 2 inches main drain valve.
- System pressure guage.
- Supply pressure guage.
- Bypass check valve.
- Alarm control and test valve.
- Retainer chamber.
- Water motor alarm gong.
- Pressure operated alarm switch to actuate a bell

Alarm check valve shall be connected to the main control panel. The control panel shall have auto, manual and off selector switch. If the selector switch is in either off or manual position, an alarm signal should be sent to the main Fire Control and fire alarm panel.

## **4.9 VALVES**

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

### **4.10 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.

### **4.11 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.

## **5. CLEAN AGENT FIRE EXTINGUISHING SYSTEM**

### **5.1 DISCHARGE NOZZLE**

Discharge nozzle shall be listed for intended use. Listing criteria shall include flow characteristics, area coverage, height limits and minimum pressure, as per NFPA standards or as per manufacturer's recommendation. Discharge nozzle shall be permanently marked to identify the manufacturer as well as the type and size of orifice. Nozzles shall be installed so as to free of any obstruction that could interfere with proper distribution of discharge agent.

### **5.2 DETECTION, ACTUATION, ALARM AND CONTROL SYSTEM**

The clean agent shall be controlled by listed clean agent releasing control panel. That is listed for monitoring the associated initiating device, meet the listed compatibility requirement for actuation of the system releasing device and controls the system notification appliances. Alarm system shall also be connected with the control panel of the system. The clean agent suppression system releasing control panel shall not be dependent upon or affected by the operation or failure of protected premises building fire alarm panel. Automatic detection, automatic actuation, alarm and control system shall be installed as per NFPA standards or as per manufacturer's recommendation.

### **5.3 OPERATING DEVICES**

All devices shall be located, installed or suitably protected so that they are not subject to mechanical, chemical or any other damage that would render them inoperative. A means of manual release of the system shall be accomplished by mechanical manual release or by electrical manual release when control system monitors the low-battery signal.

## **5.4 STORAGE CONTAINER ARRANGEMENT**

Storage containers and accessories shall be located and arranged so that inspection, testing, recharging and other maintenance activities are facilitated and interruption of protection is held to minimum. Storage containers shall be installed and secured according to manufacturer's recommendation or as per NFPA standards or listed installation manual.

## **6. 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).

### **6.1 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.

### **6.2 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.

### **6.3 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.

## **6.4 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.

## **6.5 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.

## **6.6 TYPES OF EXTINGUISHERS**

### **6.6.1 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.

### **6.6.2 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.

### **6.6.3 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.

## **6.7 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.

## **7. INSTALLATION AND TESTING OF PIPES**

### **7.1 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.

### **7.2 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.

### **7.3 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.

### **7.4 LAYING OF PIPES**

#### **7.4.1 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 Contractor 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.

#### **7.4.2 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.

## **7.5 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).

## **7.6 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.

## **7.7 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.

## **7.8 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

## **8. MEASUREMENT AND PAYMENT**

### **8.1 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.

### **8.2 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**
- 2.0 MATERIALS**
- 3.0 APPROVAL OF MATERIAL AND EQUIPMENT**
- 4.0 INSTALLATION**
- 5.0 FLUSHING**
- 6.0 LEAKAGE TEST**
- 7.0 RETESTING AFTER BACKFILL**
- 8.0 PIPE LINE DISINFECTION**
- 9.0 FINAL FLUSHING**
- 10.0 SAMPLING AND TESTING**
- 11.0 CLEAN UP**
- 12.0 WASHOUTS**
- 13.0 AIR VALVES**
- 14.0 MEASUREMENT AND PAYMENT**

## **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° degrees for Asbestos Cement Pipe 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.

#### **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, silt, 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:

$$L = 0.00054 \text{ ND} / P$$

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**
- 2.0 APPLICABLE STANDARDS**
- 3.0 SUBMITTALS**
- 4.0 MATERIAL AND EQUIPMENT**
- 5.0 DELIVERY, STORAGE AND HANDLING**
- 6.0 MEASUREMENT AND PAYMENT**

## **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\*\*\*

# **BIO MEDICAL GASES WORKS**

<b>S. No.</b>	<b>Description</b>	<b>Page No.</b>
01	Specification Section 8467	8467-1 to 8467-45
02	Special Provision Section 9000	9000-1 to 9000-9

## SECTION 8467

### MEDICAL VACUUM, AIR AND GAS SYSTEMS

#### PART 1 - GENERAL

##### 1.1 SYSTEM DESCRIPTION/SCOPE OF WORK

- A. The Contractor shall include for supply, manufacturer's work testing and certification, delivery, off loading, installation, site testing and system proving (in whole or in sections), commissioning, demonstration and leaving in proper working order. The centralized piped medical gas and vacuum supply systems, as indicated on the relevant drawings and in accordance with the specification. **All supplied equipment shall be new and never used as Prototype.**
- B. The medical gas services shall comprise the following systems (where applicable):
- Oxygen
  - Nitrous Oxide
  - Medical Compressed Air System
  - Surgical Compressed Air System
  - Medical Vacuum Systems
  - Anesthetic Gas Scavenging Systems (A.G.S.S.)
- C. Plant locations shall be as shown on the drawings.
- D. Number of outlets shall be as shown on the drawings and as specified in HTM 02-01.

##### 1.2 RELATED WORK/STANDARDS

- A. The equipment and installations shall comply with all relevant Standards and Codes of Practice, comprising:
1. BS 5682
  2. BSEN 737-2 (1998)
  3. N.H.S. Model Engineering Specification, Code C.11.
  4. H.T.M. No. 02-01: 2006
  5. ISO 10083
  6. ISO 7396-1
  7. Medical Device Directive 93/42/EC Class II b
  8. European Pharmacopeia – Oxygen 93 (Latest Edition)

##### 1.3 QUALITY ASSURANCE

- A. Special Qualifications
1. The Contractor shall include for the services of a specialist installation contractor, well experienced in the installation of medical gases and vacuum services and capable in every aspect of the work. Provide strict supervision at all times during the currency of the work.
  2. The specialist installation contractor shall give an undertaking in writing, with their tender bid, that the Installation personnel are well versed in the installation of Medical Gas Services and capable and competent in all aspects of the work.
- B. Special Requirements
1. Where compressed air is to be used as Medical Air it shall not be used for controls systems or other non-medical applications.



2. Medical air supplied to respirable air terminal units for operation theaters shall be supplied from a minimum duplex compressor/receiver installation operating at a pressure sufficient to provide the correct flow and pressure at the farthest 4 bar B.S. terminal outlet.
3. Regulators shall be provided upstream of the terminal units to effect pressure reduction.

#### 1.4 REFERENCES/STANDARDS

- A. The whole of the medical gas services, medical compressed air service and vacuum service shall be provided in compliance with the requirements of Health Technical Memorandum No. 02-01 (i.e. H.T.M. 02-01), published by the Department of Health and Social Security, London and the January 1990 Edition of C.11 document previously mentioned and with all relevant British Standards referred to therein; and as supplemented by the requirements of this specification.
- B. The Contractor shall comply with all statutory obligations and undertakings for compliance with the H.T.M. No. 02-01:2006 supplementary publication entitled "Permit to Work System" issued March 1977 by the Department of Health and Social Security; when making connections to the existing oxygen systems.

#### 1.5 SUBMITTALS

- A. Product Data
  1. Descriptive literature for each of the actual proposed equipment to be used including:
    - a. Capacity
    - b. Dimensions and weights
    - c. Operating pressure ranges
    - d. Pressure losses
    - e. Flows
    - f. Test Reports
    - g. Certificates of approval
    - h. Operation and Maintenance Data
    - i. Any other technical data
- B. Shop Drawings
  1. Shop drawings for each of the actual proposed equipment shall include the following:
    - a. Working or manufacturing drawings
    - b. Calculations
    - c. Installation details
    - d. Connections by other services
    - e. Wiring and control diagrams
    - f. Accessories available indicating those included
    - g. Pictures and system diagrams

#### 1.6 DELIVERY, STORAGE AND HANDLING

- A. Great care shall be exercised in the storage and handling of all materials, and in the condition of tools used in cutting, to prevent oil or grease being introduced into the piping.
- B. Fittings shall be specially finished for use with medical gases and be delivered to site, in sealed polythene bags. The bags shall be securely fastened and clearly labeled "For use with piped medical gas".

All the material for Medical Gas Systems delivered to site shall be inspected and stored in the manufacturer's sealed bags, under the supervision of specialist contractor for the medical gas installation.

All equipments shall be stored strictly in accordance with manufacturer's recommendations and access to stores shall be limited to qualified persons only.

C. Degreasing of Works.

1. All pipes, fittings, valves etc., for oxygen, nitrous oxide, compressed air supplies and vacuum shall be degreased and dried internally at the manufacturer's works immediately following which they shall be sealed with purpose made plastic plugs.
2. The degreasing process shall be such that there is no possibility of contamination of pipes, fittings, valves etc., by poisonous substances introduced by the degreasing agent.
3. A certificate shall be supplied by the manufacturers showing details covering the supply of each batch, certifying that degreasing and subsequent complete removal of degreasing agent has been carried out.
4. In order to meet this degreasing requirement, pipes up to and including 50 mm internal diameter shall be steam cleaned internally, dried shot blasted and blown through with medical quality air and individually capped at both ends, after passing a visual internal inspection, at manufacturer's works.
5. Pipes above 50 mm shall be similarly cleaned if this can be done economically, or if not, they may be solvent cleaned with an approved agent (such as trichloroethylene or methyl chloride), leaving no poisonous residues, then dried and individually capped at both ends, after a visual inspection bundled pipes shall be sealed with an adhesive tape marked "Medical Gas Pipes".
6. Where any contamination of the internal service is suspected, such materials shall not be installed for medical gas or compressed air services.

D. Cleanliness

1. All valves shall be thoroughly cleaned of all oil and grease before leaving the manufacturer's works and dispatched to site in sealed polythene bags marked as specified above.
2. When any section of pipe work is left incomplete for any purpose, the pipe shall be securely sealed with purpose made plastic blanking caps. Other protective measures shall include the sealing of components in polythene bags or boxes, and the adequate wrapping of materials, in an approved manner.
3. All containers supplied to site shall be labeled "Degreased for Medical Gas Service".

PART 2 - PRODUCTS

2.1 PIPING AND FITTINGS

- A. Pipe work materials shall be manufactured under licensee of the B.S. 5750 (or ISO9000) Quality Assurance certification scheme.

Pipes shall be constructed from phosphorous de-oxidized, non-arsenical copper to B.S. 6017 Grade C106 and be manufactured in accordance with B.S. 2871: Part 1 Table X or Y or equivalent.

All pipe work shall be degreased as described in paragraph 1.6.C of this section, capped and marked for medical gas service before delivery to site and shall be free from visible flattening, buckling or evidence of wall thinning and shall be free from burrs and scale.

The entire pipe work shall be electrically continuous and shall be bonded to the main electrical earthing system, as required by HTM 02-01 or NEC and as per instructions of the Engineer.

Bonding shall not form part of the medical gas contractor's responsibility, but shall be carried out by the electrical Sub-contractor, for the works.

Pipe work for vacuum pump exhausts shall be installed in galvanized mild steel tube to B.S. 1387 'Heavy' Quality or solvent welded PVC pipe work.

Pipe work within bed head services shall be run in a separate compartment from the electrical services.

Except for bed head services and pendant devices, the installation Contractor shall ensure that pipelines are physically separate from the metal sheath and armor of electric cables and from metal conduits, ducts, trunking and bare earth continuity conductors, associated with any cables.

- B. Non-electrically conducting flexible connections shall not be used on medical gas systems and shall only be used where approved between vacuum pumps air compressors and the fixed pipelines, and shall be bonded across to comply with this requirement. The Bonding method shall be by the specialist installation Contractor.
- C. Fittings shall be constructed of phosphorous de-oxidized, non-arsenical copper to B.S. 6017 Grade C.106, be manufactured in accordance with B.S. 864, Part 2, end feed capillary type units suitable for a working pressure of 8 bars and be used in conjunction with the specified brazing rods.
- D. Pipe work diversion set shall be formed in one piece from a long length of tube and shall be cold drawn or fire drawn in a neat manner, without buckling or thinning, having straight position not less than 100 mm long at each end. Hot forming shall only be carried out using an inert gas shield internally, to prevent the formation of internal oxides. The use of fittings for diversion sets will not be permitted except for pipe work over 28 mm diameter.
- E. Pipe work Installation:
  - 1. The specialist installation Contractor shall supply and fix all pipe work and fittings in the positions indicated on the drawings in a neat manner without springing or forcing.
  - 2. Pipe runs shall wherever practicable, have clearance of at least 25 mm maintained between each service. Where this is not possible, pipe work shall be electrically bonded, wrap insulated or equivalent.
  - 3. Pipe surfaces, including any protective covering shall be left sufficiently clear of walls and other structures, to enable painting of walls or structures to be carried out without defacing or altering color and contents indications of the medical gas pipeline.
  - 4. The specialist installation Contractor shall supply all necessary building work details to the Contractor and shall be responsible for the accuracy of these details.

5. Where pipe work is installed as an extension to an existing system or an interconnection thereto, the specialist installation Contractor shall adequately isolate the system at the nearest isolating valve, physically disconnect the line to be worked on and blank off, downstream of the valve, the line to remain in use.
6. Reconnection shall not be made until the new and altered installations are complete, with the final connection being made when all tests required on the new extension/new works have been completed, and has been accepted by the Owner's Representative.
7. Existing medical gas installations shall not be interfered with, without the necessary "permit to work" being obtained.
8. Piping shall not be run in ducts where access is difficult or where there is a hazard due to poor ventilation or where a required clearance from electrical and other services cannot be maintained.

F. Pipe work Jointing Techniques:

1. Copper to copper joints shall generally be used throughout the Medical Gases installations.
2. Mechanical joints shall be made only where pipelines are connected to items such as valves and control equipment.
3. Copper to copper joints shall be made using brazing filler rods suitable for use without flux. No flux shall be used.
4. The brazing material shall be silver-copper-phosphorous alloy (Type CP1 or CP4) in accordance with B.S. 1845.
5. Brazing or any heat process shall be carried out in the presence of an inert gas shield i.e. Nitrogen which shall be introduced into the pipeline to prevent the formation of oxides.
6. Where copper joints to brass, gunmetal or bronze fittings are essential, these shall be formed using copper tails so as to permit the ultimate connection of the fitting into the pipe work system by means of the flux less brazing procedure described above.
7. Brazing to brass, gunmetal or bronze fittings shall be carried out using a copper-silver-zinc alloy in accordance with B.S. 1845 together with an appropriate flux.
8. The flux residues and copper oxides created by this process shall be removed chemically and the complete assembly cleaned, degreased and individually packed and sealed prior to delivery to site.
9. Heating of joints for brazing shall be carried out with oxygen/acetylene, acetylene, hydrogen, LPG/ambient air or torches.
10. No joints in pipe work, other than the capillary joint to a terminal tail pipe, or a connection to a valve in a box, shall be buried within the thickness of walls, partitions or floors. Where this is completely unavoidable the pipe shall be carried in a copper sleeve. Where pipe work has to be buried in a partition the terminal units and boxed valves shall have tail pipes which extend to the ceiling void or duct, rather than have buried joints to the conventional short tail pipes.

11. The contractor shall ensure that an adequate lighting level is maintained at all locations where jointing work is to be carried out to assist in ensuring high joint quality.

G. Use of the Inert Gas Shield:

1. The inert gas shield comprising an inert gas of oxygen-free Nitrogen to B.S. 4105 shall be supplied to the inside of the pre-assembled unbrazed pipe work through a pressure regulator and flow controller or flow regulating device.
2. Prior to brazing, the assembled pipeline shall be flushed with nitrogen, to remove all air.
3. This shall be followed during the brazing operation by a continuous flow to prevent the ingress of air.
4. Pipe ends may be capped as necessary to direct the flow of Nitrogen into sections of the pipe or pipes being brazed.
5. Particular attention should be paid to the purging of tee joint fittings.
6. If working for prolonged periods in very confined spaces, precautions shall be taken to avoid excessive build up of Nitrogen by ventilating the space where work is being carried out or by piping the shield gas safely out of the space.
7. If, in the opinion of the Engineer the Threshold Limit Value is being exceeded during construction, the Engineer shall require the specialist installation Contractor to monitor the level of carbon dioxide in the presence of the Engineer.
8. It will however be the responsibility of the specialist installation Contractor to provide and use suitable detection equipment, where necessary, and inform the Engineer of any potentially hazardous situation.
9. Such monitoring shall be carried out at the specialist installation Contractor's expense.
10. The specialist installation Contractor and the Engineer shall jointly keep a record of nitrogen cylinders held on site. These shall be accounted for and removed from site on completion of the contract and must not become mixed up with Medical Gas Cylinders.

H. Inspection of Joints:

1. Pipe work joints shall be inspected as follows:
  - a. Before pressure testing, and after brazing, the Engineer shall identify these fittings which are required to be removed for examination.
  - b. The number of fittings so selected for examination shall not be less than three in every two hundred fittings installed and these shall be cut out in the presence of the Engineer, be quartered longitudinally and examined.
  - c. On examination the tube and fitting shall be internally clean and free from oxides and particulate matter and the minimum penetration of the brazing alloy at any point on the joint shall be at least five times the wall thickness of the tube or 3 mm, whichever is greater.

- d. If on examination the joints are found not to conform to the above requirements then adjacent joints shall be cut out until the full extent of faulty workmanship has been established.
- e. The pipeline shall, thereafter, be made good using the materials and techniques described in this Specification, at the Specialist Sub-Contractor's expense.
- f. The joints examined and found to be acceptable shall be made good using the materials and techniques described in this Specification, at the Specialist Sub-Contractor's expense.
- g. Supports:
  1. The pipeline shall be adequately supported at sufficient intervals, in accordance with the following table, to prevent sagging or distortion. Supports shall be provided on horizontal and vertical runs and shall be arranged to minimize stress on fittings and joints.
  2. On horizontal pipe runs supports shall be located close to risers and drop legs to minimize stress due to the weight of vertical pipes and fittings. Supports for surface mounting pipe work shall provide clearance to permit painting of the surface.
  3. Where it is essential for pipes to cross electric cables or conduits, they shall be supported on both sides of the crossing and prevented from touching the cables or conduits. Supports shall be of suitably treated material to minimize corrosion and prevent electrolytic action between pipes and supports.

PIPES SIZE	MAX. INTERVALS FOR VERTICAL RUNS	MAXIMUM INTERVALS FOR HORIZONTAL RUNS
8-12	1.2 M	0.9 M
15 mm	1.8 M	1.2 M
22-28 mm	2.4 M	1.8 M
35-42 mm	3.0 M	2.4 M
54 mm	3.0 M	2.7 M
76 mm	3.6 M	3.0 M

4. No pipes shall be run in trenches or be buried. They may be run in crawl ways, ducts, ceiling voids and wall voids, except where specified or indicated otherwise.
5. Pipe work shall not have joints buried in any wall, until that section of pipeline has been satisfactorily tested. Joints in walls shall be kept to an absolute minimum.
6. Bracketing assemblies from structural or other soffits in ceiling voids where no common support rail is provided shall comprise of standard bracketing components including a primary system from the building structure, fixed in accordance with the general specification clauses.

7. Where a common support rail is provided by the Contractor, the Specialist Installation Contractor shall supply and fix standard bracketing components.
8. Bracketing assemblies for use in plant rooms may incorporate the previously described support systems. For copper pipe work each saddle guide shall be provided with a chafing pad to isolate the pipe from the bracket.
9. The Contractor shall arrange for all openings and drill all holes required in building structures and structural steel etc., to accommodate the fixing of brackets and hangers requiring such facilities and shall fix common support rails.

## 2.2 VALVES

### A. General:

1. All valves necessary for the complete medical gas systems shall be provided by the specialist installer in the positions indicated on the drawings or shall be positioned in the pipeline systems, in accordance with medical gas recommendations, in compliance with H.T.M. No. 02-01:2006
2. Valves on the distribution systems shall be of the non-lubricated type and of non-ferrous metals and shall be suitable for the test and working pressures of the system.
3. All valves shall be provided with copper pipe stubs for facilitation of copper to copper jointing on site. Connections of pipe stubs to valves shall be by means that eliminate the use of sealing tape or compounds.
4. Details of the make, type and catalogue numbers of the valves proposed for the installation, shall be listed and forwarded to the Owner's Representative for approval.
5. The same type of valve shall be used throughout the medical gas installation, as far as this is appropriate.
6. All valves shall close in a clockwise direction and the direction of closing shall be clearly marked.
7. Valves shall be readily accessible in an emergency from the area served by the section of pipe work and they shall be routed at a height of 1200 mm from floor level.
8. Each valve located outside lockable plant rooms used for medical gas plant only shall be mounted in a standard box, irrespective of its function. Any valves larger than 28 mm which are not required to be operated in an emergency may be accommodated in readily accessible parts of duct, or in ventilated cupboards, provided they are lockable in the open and closed positions.
9. All valves for medical gases/medical vacuum shall be tested at the manufacturer's works, to a pneumatic test pressure of 16 bar and after satisfactorily passing the test, shall be thoroughly cleaned for all oil and grease.
10. Marking: Each valve shall be indelibly labeled to indicate the name of the service, the zone they control and shall be stamped or engraved with a test certificate number/identity plate for operational purposes.

11. Packaging: Each valve shall be delivered clean, sealed in a polythene bag. All bags shall be securely and clearly labeled "for use with piped medical gases".

B. Isolation Valves:

1. Isolating valves should be provided downstream of non-return valves and upstream of, for example, the connection of the emergency reserve manifold.
2. Isolating valves shall be of the screwed lever operated ball type. All valves shall give a clear indication of the ON and OFF positions.
3. Manually operated isolating valve shall allow isolation to facilitate maintenance or replacement of plant items and components such as receivers, dryers, automatic drains, pressure regulators.

### 2.3 AREA VALVE AND SERVICE UNIT (A.V.S.U.)

- A. All medical gas valves in locations which are readily accessible to unauthorized persons shall be enclosed in an approved flush mounted box of robust construction, as detailed on the drawings. The design of the box shall include the following:

1. A lockable hinged cover with lock and key and with a transparent replaceable, breakable, panel for access to the valve in emergency.
2. Vents at the top and bottom to permit the circulation of room air in and out of the box to prevent concentration of gas due to leakage from the valves.
3. Free access to each valve for operation and servicing or replacement.
4. Space to facilitate the fittings of the valves to the pipe and permit easy operation of the valve with the cover open and through the breakable panel in emergency.
5. Space within the box for fixing a valve identification label.

- B. A.V.S.U.'s shall be fitted in positions shown on the drawings and schedules and where indicated more than one valve may be accommodated in one box.

The boxes shall be mounted with their base 1200 mm above the Finished Floor Level and in clear view of a normally-staffed location (e.g. Nurse Station). Where an alarm panel is specified or indicated on the drawings for the area served by the AVSU, it shall be mounted adjacent to or above the AVSU.

For each service a pressure gauge shall be provided in addition to the valve and upstream of it.

- C. Clear indication shall be provided on the panel of which services are included within the box and which area these serve. The form of sign writing or labelling shall be to approval.

For example:

OXYGEN VALVE FOR GYNAE DEPARTMENT

IN EMERGENCY, BREAK GLASS TO CLOSE VALVE.

TO BE USED BY AUTHORIZED STAFF ONLY.



Each valve shall have secured adjacent to it, an engraved label with black lettering on a white background giving the following information:

1. Key number
  2. Code reference of valve
  3. Gas being controlled
  4. Gas outlets being controlled
- D. The valves shall be of the screwed lever operated ball type but flanged diaphragm type valves shall be used for vacuum pipelines.
- E. A.V.S.U.'s shall be designed to have a minimal pressure drop and shall be capable of passing 400 liters/min of gas at the normal working pressure.
- F. Each A.V.S.U.'s shall have two gas specific NIST fittings, in accordance with B.S. 5682:1984, incorporating non-return valve and non-blanking caps.
- G. The Nists shall be suitable for purging, gas sampling or emergency gas supply; and the valve shall be maintainable without interruption of the gas supply. A.V.S.U.'s shall incorporate facilities for blanking.
- H. The keys for valve boxes shall be non-interchangeable, in support of the "permit to work" system.

#### 2.4 COMPRESSED AIR REDUCING VALVES AND PRESSURE REGULATIONS

- A. Reducing valves or pressure regulators shall be provided at all required points in the system, to provide the necessary pressures at outlets. Every reducing valve shall be fitted with a safety valve in the low pressure side, and the safety valve shall discharge in a safe manner, to avoid risk of injury to persons or property.
- B. Pressure regulators shall be of a type which automatically prevents the build up of excessive pressure in the low pressure side.
- C. The assembly shall be provided with accurate pressure gauges, located one on each side of the valve, conforming to the requirements of B.S. 1780.

#### 2.5 MEDICAL COMPRESSED AIR SYSTEM

A. General:

Medical compressed air system shall comply with European Pharmacopoeia for breathable Air. The entire compressed air system shall be designed and installed, in accordance with the recommendations of H.T.M. No. 02-01:2006 and C.11 specification dated January, 1990 respectively; and as supplemented by the requirements of this specification, covering the plant.

The plant shall provide an average continuous demand (ACD) as indicated on drawings, with one compressor stationary, irrespective, if duplex or multi compressor units.

The plant shall be capable of producing flow rate as mentioned in drawing at a continuous plant flow rate of 100% and at 10% of A.C.D. over a 6 hour period.

B. Air Compressors.

1. As a minimum requirement, the compressed air shall be provided from a duplex air compressor set, complete with after coolers, air receivers, starter control panel dryers and Duplex filter/regulator assembly. The plant shall operate at a pressure sufficient to produce the correct pressure and flow rate at the farthest nominal 4 bar outlet. Multiple compressor units may also be considered.

The system shall be complete with all non-return valves, isolating valves, gauges and differential pressure switches.

2. Generally any type of air compressor plant may be provided; with the exception of water sealed units, which shall not be allowed. The packaged shall be designed for ease of maintenance with commonly available spare parts.
3. An air intake filter and silencer shall be provided for each compressor together with a multi-purpose test point and an emergency/reserve manifold facility.
4. Air compressors shall be suitable for continuous running on-load and for start/stop operation. Each air compressor shall be driven by a T.E.F.C. electric motor constructed to B.S. 2613 and B.S. 2960 with Class F insulation and Class B temperature rise; arranged for star delta starting and suitable for 380 volt, 3 phase, 60 Hz A.C. electrical supply.
5. Compressor starter units, manufactured and installed in accordance with IEE regulations, shall incorporate all necessary safety interlocks and manual reset facilities and shall operate their respective compressor(s) only.

All necessary circuit protection fuses (BS 88) or circuit breakers (BS 4752/BS 3871), industrial ammeters, hour counters and mains supply on indication, shall be provided.

C. Receiver

1. Air receivers shall be horizontal and cylindrical, suitable for the required system working pressure and be fitted with gate valves, in line non-return valves, pressure gage, automatic drain trap with manual by-pass, Inspection Door and safety valve. Sizes of receivers shall be justified by calculation and shall provide a minimum water capacity equivalent to 50% A.C.D.

2. All receivers shall be manufactured in accordance with BS 5169: 1975 Class 3 and manufacturers test pressure certificates shall be furnished to the Engineer, in compliance with all necessary requirements and codes for pressure vessels.

All receivers shall be supplied complete with suitable lifting lugs and mounting feet.

3. The controls for the compressor pump motors shall be arranged so that one motor starts at lower pressure than the other, with automatic standby arrangement, in the event of failure.

The pressure shall be controlled by relevant pressure switches that will start or stop the appropriate compressor motor, when the pressure in the receiver reaches their pre-set value.

D. Plant Operating and Indicating Systems

1. The medical compressed air plants shall incorporate all necessary plant monitoring and indicating systems. Components of these systems shall have a guaranteed life of one year in continuous use and a design life of five years under the same conditions. They shall be suitably identified as to their function/indication.

As a minimum requirement, the following facilities shall be provided under the plant operating and indication system; in full compliance with HTM 02-01 and specification document C.11, January 1990:

- Plant control unit, providing overall plant control.
  - Compressor starter units, for individual compressor control.
  - Filtration/dryer assembly control units.
  - Plant status monitoring and indication unit.
  - Plant to alarm system interface unit.
  - Facilities for repeat of status and alarm signals to the BMS shall also be provided.
2. These facilities shall be incorporated within a common control panel located either on the plant or on the wall of the plant room, with separate compartments provided to house individual starter unit(s). All interconnecting plant and control wiring shall be provided and installed by the specialist contractor. Systems shall be capable of automatically restarting on reinstatement of power supplies.
  3. The plant control unit shall be manufactured and installed in accordance with IEE Regulations and shall incorporate a manual pre-set facility (and manual override facility), in order that either compressor can be selected as the 'duty' compressor.

The control unit shall derive its power from a separate sub-circuit from the "yellow phase" for each plant; and shall have power supplies to each compressor, controlled by their own individual sub-circuits.
  4. The control unit shall incorporate duty/standby selection facilities and be designed such that no single component failure results in loss of plant output and that the control philosophy is such to ensure that two compressors will not start simultaneously when power is applied. Warning notices to BS 5378 shall be provided.
  5. Actual selection of setting shall be made after selection of all equipment and total pressure losses have been established. Provision for twenty four hour automatic reversal of the starting sequence shall be provided to even up the wear on the compressors. The control arrangement shall ensure that in the event of heavy demands or failure of one compressor, the standby compressor is brought into action, automatically.
  6. Plant status monitoring facilities shall detect faults on the compressed air plant and shall transmit indication to the plant status indicator unit and the plant to alarm interface unit, respectively.
  7. Compressor fault indication shall comprise control circuit failure, overload trip condition, after cooler high temperature fault, activation of plant/system safety devices or failure of compressor to respond (within permitted run-up time). Dew point and pressure fault monitoring of each filtration/dryer unit shall also be provided, under the works.

8. Monitoring of plant emergency status shall be provided comprising:  
  
Receiver pressure fallen 0.5 bar below standby compressor cut-in pressure.  
  
Dew-point condition above -26°C at atmospheric pressure.  
  
Reserve manifold bank pressure fault when below 68 bar pressure.
9. Pipeline pressure fault monitoring facilities for both low pressure (412 KPa) and high pressure (503 KPa), to be provided for the 4 bar breathing air line. Corresponding facilities shall be provided for the surgical air system.
10. The plant status interface unit shall provide indication of each of the aforementioned plant/ system faults and shall transmit same to the plant to alarm interface unit, to be recorded as a plant fault via the appropriate volt free contacts.
11. The plant to alarm system interface unit, supplied via an independent electrical supply, shall display the system status conditions comprising normal, plant fault, plant emergency, reserve cylinder banks below 68 bar pressure and relevant pipeline pressure fault conditions.
12. System status conditions shall thereafter be transmitted to the central alarm system.
13. Monitoring and indication of input line faults or external wiring circuits shall be provided within the system.

E. Air Dryers

1. Duplicate desiccant air dryers shall be provided, complete with electrical control box and timer, etc. Each dryer shall be capable of meeting the continuous full load capacity of one compressor. Either dryer assembly may be selected as 'duty', with the second on 'standby', fed from separate power supplies taken from the same phase.
2. Separators/pre-filters shall be installed upstream of each air dryer assembly, capable of providing air with a maximum oil content of 0.5 mg/m<sup>3</sup> at STP, with particle removal down to 1 micron and DOP penetration of less than 0.03%.
3. In addition, after filters of equivalent specification, shall be installed downstream of each dryer assembly. Facilities for the removal of hydrocarbons, odors and vapors shall also be provided, via activated carbon filters.
4. Separators shall be complete with moisture traps incorporating automatic drain facilities, with manual by-pass.
5. Dryers shall be of the desiccant type, having two columns, air regenerated and fully automatic. Dryers shall be used and regenerated alternatively.
6. The quality of medical air leaving the filter/dryer assemblies, shall be such that, a maximum remaining oil content of 0.01 mg/m<sup>3</sup> at S.T.P., shall not be exceeded, with corresponding particle removal down to 0.01 micron and D.O.P. penetration of less than 0.0001%.
7. Dryer control facilities, utilizing purge air for the regeneration process, relative to pipeline demand, shall be provided by:

- a. Monitoring dew point or bed saturation conditions.
  - b. Pressure fluctuations in the receiver.
  - c. By interrupting process timers, in accordance with compressor operation.
8. Bleed air from column type dryers shall be controlled, by readily accessible valves, to enable one set to be regenerated without interrupting the supply. Outlets shall also incorporate silencers, discharging over an appropriate tundish.
  9. Each dryer shall be designed to provide a desiccant bed life of not less than two years on continuous full load and each should be fitted with a safety valve and pressure gauge.
  10. The filtration/dryer assembly shall incorporate suitable control unit containing duty selector switch, on/off selector switch, all regeneration control provisions, dew point sensor and pressure fault sensing; together with auto changeover facilities and function indicators, as defined in C.11 specification document, dated January 1990.
  11. The control circuit shall be designed such that all fault indications remain until manually reset via reset button, and that auto-changeover of dryers shall be activated in the event of either dew point failure or any other system malfunction, causing rapid de-pressurization; and shall remain so, until the fault has been identified and rectified.
  12. On loss of power supply to the system, the controls shall close the exhaust and purge valves and also open inlet and outlet valves respectively.

F. After Coolers

1. After coolers of the air cooled version, shall be provided for each compressor. The air discharge temperature shall not exceed 15 degrees C above the cooling air inlet. The compressed air shall be of sufficient dryness that precipitation shall not occur if an equivalent amount of air is reduced to minus 18 degrees C at 7.0 bar gage.
2. Each after cooler shall be fitted with an automatic drain trap and a manual by-pass valve for draining the condensed moisture from the air side. Thermometers shall be provided on the compressed air inlet and compressed air outlet.

G. Compressed Air Ancillaries

1. Moisture removal shall be provided by automatic drain traps, of the electrically or mechanically operated type, at after-coolers, air receivers, separators and filters; with visible discharge to gully or tundish. Manual drain facilities shall also be provided.
2. Separators complete with strainer, trap, sight glass and check valve, where applicable, shall be installed on the high-pressure side of all pressure reducing valves to ensure a supply of dry air at the valve inlet.
3. Drain lines from relay points in compressed air lines shall be provided with strainer, trap, sight glass, where applicable, and a stop valve. The top shall be rated to withstand the working pressure of the system.
4. All separators shall be suitable for working pressure with a minimum 20% safety margin.

5. Pressure reducing sets, float traps and other fittings and instrumentation shall be as described in other sections of this specification.
6. Pipeline pressure on the medical compressed air system shall be controlled at 7.0 bar to achieve 4.1 bar at terminal unit by a duplex, non-relieving pressure regulator assembly; which shall be designed to have a static pressure under NO flow conditions of 473 KPa and a minimum delivery pressure of 437 KPa.
7. The pressure regulator assembly shall include isolating valves, pressure reducing valves, safety relief valve, dew point alarm low and high line pressure alarm and line pressure gauge.
8. Provision shall be made for the supply and installation of an automatic emergency manifold with pressure regulator, cylinders and rack, with a capacity of one day's compressed air requirements and facilities for manual changeover to the reserve bank.
9. Relief valves shall be fitted integrally or separately, within the system, one on the delivery pipe downstream of each compressor and upstream of any isolating valve, non-return valve or after-cooler, capable of discharging the total throughput of the compressor.
10. Relief valves shall also be fitted, one on each air receiver capable of discharging the total throughput of the compressor(s) and downstream of any pressure regulators, other than line pressure regulators.
11. Safety valves to comply with B.S. 1123, shall be installed immediately downstream of each line pressure regulator, arranged to discharge safely, so that there is no danger to personnel in the plant room.
12. Safety valves shall be capable of discharging the total throughput of the plant at a maximum pressure of 649 KPa and re-set at 507 KPa minimum pressure.
13. Safety valves shall have a minimum lift pressure of 534 KPa.
14. Air intake filters shall be provided on the air inlets associated with each compressed air plant; in positions indicated on the drawings, such that it is remote from any contamination zone. Air intake filters shall be of the medium type to B.S. 1701, having a dust retaining efficiency of 98% minimum (Grade C.A.) when tested in accordance with that standard, fitted to the inlet of each compressor.
15. Multi-purpose test points shall be installed at the plant/pipeline interface before the NRV and comprise in sequence (after the connection point) a lockable valve, terminating in a female parallel 1", 2" or 3" BSP connection suitably plugged. Provide also, an additional connection (before the above lockable valve) having a lockable needle valve for sampling the quality of air.

## 2.6 SURGICAL COMPRESSED AIR SYSTEM

- A. The surgical compressed air system shall comply with the specification clauses previously defined, for the medical compressed air system; but the following deviations shall apply:
  1. The plant shall comprise a simplex compressor installation and not a duplex one, as in the case of medical C.A. facility.
  2. The surgical compressed air system shall comprise a packaged assembly, capable of providing a minimum capacity as mentioned in drawings at FAD (STP), with a regulated line pressure of 10 bar, suitable for regulation at plant to 7 bar.

3. The system shall incorporate single H.P. compressor, comprising two stage, oil lubricated reciprocating compressor, mounted on a horizontal air receiver/vessel, together with pre-filter (oil), single regenerated desiccant dryer, carbon filter (dust), sterile final filter, regulator, controls and control panel; to give the necessary air quality.
- B. All common system components and provisions, such as isolating and non-return valves, gauges, pressure switches, plant operating and indicating systems, air intakes, dryer controls, alarm contacts, test facilities and the like, applicable to medical C.A. systems, shall apply in this instance; in accordance with specification document C.11, January 1990.
- C. The specialist installation contractor shall furnish and install all local regulation devices as necessary, at individual terminal units in locations indicated on the drawings.

## 2.7 EMERGENCY / RESERVE MANIFOLD FOR MEDICAL COMPRESSED AIR SYSTEM:

- A. The medical compressed air system shall incorporate automatic reserve manifold facility, comprising two banks of 5 No. cylinders, connected permanently into the distribution pipeline, to enable a temporary supply to be available, when the main medical compressed air plant is to be serviced or has failed.
- B. This manifold assembly, located in the main manifold room of the hospital, shall be arranged to come "on-stream" automatically, if the medical compressed air plant fails. All necessary pressure sensors to detect manifold pressure for each bank shall be provided.
- C. A non-return valve shall be incorporated, at the point of connection into the main distribution pipeline for the medical compressed air system, to prevent back flow from the reserve supply to the main plant.
- D. All relevant pressure and manifold monitoring and indication, together with all alarm interfaces shall be provided by the installation contractor, in compliance with Specification C.11, January 1990.

## 2.8 MEDICAL VACUUM SYSTEM

- A. Vacuum Pumps
  1. The medical vacuum installation shall be designed and installed in accordance with the recommendations of H.T.M. No. 02-01:2006 and as supplemented by the requirements of this specification, covering the plant.
  2. The medical vacuum services shall be provided from a triplex medical pump unit complete with vacuum reservoir tank and starter control panel. The installation shall provide average continuous demand (ACD) as indicated on drawings, with one pump stationary and be designed to maintain automatically a vacuum of not less than 450 mm Hg below standard atmospheric pressure in the pipeline at the most remote terminal and 475 mm Hg within the receiver, whilst supplying the ACD of the Hospital.
  3. Each pump shall be mounted on as a separate bed plate along with its associated motor. The pump shall be mounted on suitable anti-vibration mountings.
  4. The unit noise level shall not exceed 65 dBA @ 1.0 meter distance, under free field conditions.
  5. The pump shall have non-return valves and filters fitted to the pump assembly.

6. Vacuum pumps and motors shall be suitable for continuous running and stop/start operation.
7. Each electric motor shall be adequately rated for the maximum duty to be performed, be of the T.E.F.C. type and suitable for 220 V, 50 Hz operation with A.C. electrical line voltage. Motors shall conform to B.S. 2613 and 2960; Part I respectively and shall incorporate overload protection.
8. Each starter shall have an isolator, either integral with the starter or as a separate unit and shall incorporate safety interlocks.
9. Vacuum pumps shall be capable of producing a higher vacuum than that required in the pipeline, so that the resistance of traps, filters, etc. and back pressure are overcome.
10. Each vacuum pump shall be capable of producing a vacuum of not less than 650 mm Hg (below a standard atmosphere pressure of 760 mm Hg), with a minimum capacity of 200 L/M per kilowatt corrected to STP, when the pump has equilibrated at normal operating temperature, whilst maintaining a pipeline pressure of 450 mm Hg.
11. Each pump shall be fitted with a silencer and drain cock.
12. Exhaust from the vacuum pumps shall be discharged to atmosphere above roof level via appropriate discharge cowls. Weatherproof notices shall be fixed at discharge locations stating: Medical Vacuum Discharge Point - Do Not Obstruct. Drain valves and transparent collection jars shall be provided at the lowest point of the discharge pipe.
13. A combined vacuum pump/exhaust system shall be employed, operating non-return valves at each pump connection. The exhaust system shall be such that the back pressure shall not exceed 50 mm Hg (1.0 psi) at the plant outlet; and the overall plant performance shall be taken into account when sizing pumps.
14. The plant shall be capable of being cleaned internally and externally and manufacturer shall provide appropriate cleaning installations.

B. Vacuum Reservoirs (receivers)

1. Horizontal cylindrical reservoirs shall be provided with manual drain valve. The cylinder shall be supported by cradles depending upon its position and be completed with suitable lifting lugs.
2. Receivers shall be manufactured in accordance with B.S. 5169 and to conform to H.T.M. No. 02-01:2006 in design and size. Test certificates shall be provided to the owner in compliance with statutory codes for pressure vessels. A minimum test pressure of 4 bar shall apply.
3. Receiver shall be fitted with vacuum gauge, isolating valves and flexible connections, between the tank and the pumps, in order to isolate vibration.
4. Receivers shall have a minimum capacity equal to the A.C.D. capability in L/M of the plant at 450 mm Hg.

C. Controls

1. The pressure shall be controlled by the pressure switches, located in the control board, which shall control the automatic start/stop operation of the pump and shall determine, via a selector switch, the duty pump (i.e. duty/standby selection facility).



2. The controls for the two vacuum pump motors serving one vacuum receiver shall be arranged so that one motor starts at a lower pressure than the other, with standby arrangements in the event of failure. Twenty four hour automatic reversal of the sequence shall be provided.
3. The control board providing the overall plant control; manufactured and installed in accordance with IEE Regulations, shall be suitable for either panel or wall mounting.
4. The plant control board shall not only incorporate power supplies for each plant, incorporating pump starter units (in separate compartments), but shall provide all plant status monitoring and indication function, together with alarm system interfaces, in strict compliance with Specification C.11 dated January 1990.
5. The control shall be capable of automatically re-starting plant on reinstatement of power supplies and be capable of maintaining pipeline vacuum, when the receiver is isolated.
6. The controls shall be so designed, such that no single component failure results in loss of plant output and shall ensure that both pumps will not start simultaneously when the power is applied.
7. Pump starter unit shall incorporate all safety interlocks which inhibit plant operation until manually reset. Warning notices to BS 5378 shall be provided.
8. If the manual/auto selector switch on the pump starter unit is selected to 'manual', the pump will continue to run, maintaining maximum vacuum.
9. The pressure switches, starter and changeover switch shall be electrically interconnected. The pressure switch shall be capable of manual adjustment to give the required operating pressure settings.

D. Vacuum Ancillaries

1. Two bacterial filters and drainage trap assemblies, with isolation valves, for installation in parallel in the pipeline upstream of the reservoir tank, shall be provided. The filters shall have a penetration not exceeding 0.005% at the design flow when tested by the sodium flame test in accordance with BS 3928. The filters shall have replaceable elements and the transparent bowl of the drain trap shall be suitable for sterilizing. The maximum pressure drop across the filter shall be 3.5 KPa. Assemblies shall be distinctly marked with the words "BIO HAZARD".
2. Multi-purpose test points, complete with protective screen at each outlet, shall be installed adjacent to the plant/pipeline interface, comprising connection point, lockable valve, terminating in a female parallel, 1", 2" or 3" BSP connection suitably plugged.
3. The electrical supply to vacuum pumping units shall be taken from the Hospital's "essential" standby supply.
4. Vacuum indicators/differential pressure indicators in compliance with B.S. 1780:1985 shall be provided where indicated on the drawings.
5. Non return valves shall be fitted on pump inlets and on discharge pipe work from each vacuum pump.

## 2.9 MEDICAL OXYGEN SYSTEM

- A. The medical oxygen system shall be in accordance with the recommendations of H.T.M. No. 02-01:2006 and as further upgraded within the N.H.S. Model Specification Document C.11, issued January 1990.
- B. The specialist installation contractor shall furnish and install complete with all necessary supports, oxygen gas distribution scheme, as indicated on the drawings.
- C. The main oxygen supply shall be obtained from a manifold assembly at manifold room. Refer to drawings for location of manifold room.

The works shall generally comprise a standby cylinder supply system with an outlet pressure of 4.1 bar minimum, located in the Manifold room and consisting of duty and standby banks of minimum five cylinders each connected via an automatic changeover manifold, pressure reducing and non-return valves to the supply line from the aforementioned manifold.

- D. Systems shall include all cylinder manifolds, cylinder couplers, control panel and controls, alarms, isolating valves and distribution piping, as indicated.
- E. All equipment and valves shall have 'built-in' oxygen identification and all piping shall be copper with silver brazed joints in accordance with the requirements of HTM 02-01 and those stated elsewhere in this specification.
- F. The operation of the gas bottles shall be controlled by an automatic changeover control panel and manifolds located between the duty and standby gas bottle racks. Sufficient spare bottles shall be held in store to ensure at least one week's supply. The stored bottles shall be used in rotation as they are received. The empty bottles are to be segregated from the full bottles, as they are removed from the manifolds. All necessary relief valves and pressure reducing regulators shall be provided, in compliance with C.11 Specification.

A pipeline pressure regulator shall be provided, designed to regulate system pressure of 4.1 bars.

- G. The oxygen manifold shall be supported on a robust angle iron frame bolted to the wall. The cylinder rack shall have an additional space to accommodate an emergency supply cylinder. This rack shall be securely fixed to wall and inclined slightly, to prevent cylinders from slipping and incorporate suitable means for securing the cylinders.
- H. An additional spare cylinder rack containing emergency, 5 bottle supply shall be provided and fixed to wall within the gas bottle store.

An emergency supply panel complete with main control valve, relief valve, pressure regulator and associated pipe work etc., shall be provided at side of manifold.

- I. All manifold status monitoring and indication, together with all relevant alarm system interfacing and pressure indication, shall strictly comply with the requirements of specification C.11 (January, 1990) and shall be repeated to the BMS.

The emergency manifold to the requirements of C.11 shall be connected permanently into the outgoing distribution pipeline, to enable a temporary supply to be available, when the main automatic control equipment is to be serviced or has failed; via a 3-way valve or isolating valves. The emergency manifold arrangement shall be controlled by the cylinder valves and a pressure sensor shall be fitted to detect nominal manifold pressure below 14 bar.

- J. The control panel components shall be secured to a rustproof steel back plate and housed under a quick release fiber glass cover. Three pressure gauges shall be provided, the outer two indicating manifold pressure and the third in the center indicating distribution pipeline pressure.
- K. An indication of manifold status shall be given by a five lamps. Green lamp for left hand bank running, 3 red lamps for left hand bank low pressure, line low pressure and right hand bank low pressure, green lamp for right hand bank running.
- L. The control panel shall be clearly marked with a nameplate which identifies the gas by name, chemical symbol and color.
- M. The inlet from the cylinder banks shall be complete with pressure switches, gauges and regulators arranged in parallel on the left and right hand side of the control box. The changeover valve, located centrally and connected to the cylinder bank inlets, shall be complete with low pressure regulators and pressure gauge. Two by-pass regulators shall be provided to ensure a gas supply upon a changeover valve malfunction.
- N. The connections of flexible copper tail pipes, shall be such that accidental connection to cylinders containing any other gas cannot be achieved (i.e. gas specific screwed thread connectors, M20 for Oxygen shall be provided, to connect to the manifold header). Non-return valves shall be fitted in the header, to eliminate leakage of gas when cylinders are removed from either bank. Flexible tailpipes shall incorporate cylinder connectors to suit the local supply of cylinders.
- O. The control panel shall automatically dispense the gas from one of the two cylinder banks (i.e. by changeover from 'duty' to 'reserve' cylinder bank). It shall be possible to select either bank of cylinders as the 'duty' bank, as an extension to this; it will also be possible to changeover manually to the 'reserve' bank at any time. The changeover operation will be effected by gas pressure and will therefore be unaffected by any electrical failure.
- P. The pipeline pressure shall be controlled by the panel at 4.1 bar.

#### 2.10 NITROUS OXIDE SYSTEMS

- A. Nitrous oxide installation shall be in accordance with the recommendations of H.T.M. No. 02-01:2006 and as further upgraded within the N.H.S. Model Specification Document C.11, issued January 1990.
- B. The specialist installation contractor shall furnish and install, complete with all necessary supports, nitrous oxide gas distribution scheme as indicated on the drawings.
- C. Systems shall include all cylinder manifolds, cylinder couplers, control panel, emergency supply panel, alarms, isolating valves and distribution piping, as indicated.
- D. All equipment and valves shall have 'built-in' nitrous oxide identification and all piping shall be of copper construction, in compliance with the specification applicable for medical gas pipeline systems, contained herein.
- E. The storage of nitrous oxide supplied through the piped system, shall be by a bottled supply as per location shown on drawing. There shall be two such banks of two cylinders, providing duty and standby supplies.
- F. The operation of the gas bottles shall be controlled by a control panel and manifolds located between the duty standby gas bottle racks. Sufficient spare bottles shall be held in store to ensure at least one week's supply. The stored bottles shall be used in rotation as they are received. The empty bottles are to be segregated from the full bottles, as they are removed from the manifolds.

All relief valves and pressure reducing regulators shall be provided in compliance with specification C.11.

A pipeline pressure regulator shall be provided, designed to regulate system pressure of 4.1 bars.

- G. The nitrous oxide manifold shall be supported on a robust angle iron frame bolted to the wall. The cylinder rack shall have an additional space to accommodate an emergency supply cylinder. This rack shall be securely fixed to wall and inclined slightly, to prevent cylinder from slipping and incorporate suitable means for securing the cylinders.
- H. All manifold status monitoring and indication, together with all relevant alarm system interfacing and pressure indication, shall strictly comply with the Requirements of Specification C.11 (dated January, 1990) and shall be repeated to the BMS.
- I. The control panel components shall be secured to a rust-proof steel back plate and housed under a quick release fiber glass cover. Three pressure gages shall be provided, the outer two indicating manifold pressure and the third in the center indicating distribution pipeline pressure.
- J. An indication of manifold status shall be given by a five lamps. Green Lamp for left hand bank running, 3 red lamps for left hand bank low pressure, line low pressure and right hand bank low pressure, green lamp for right hand bank running.
- K. The control panel shall be clearly marked with a nameplate which identifies the gas by name, chemical symbol and color.
- L. The inlet from the cylinder banks shall be complete with pressure switches, gages and regulators arranged in parallel on the left and right hand side of the control box. The changeover valve, located centrally and connected to the cylinder bank inlets, shall be complete with low pressure regulators and pressure gage. Two by-pass regulators shall be provided to ensure a gas supply upon a changeover valve malfunction.
- M. The connections of flexible copper tail pipes, shall be such that accidental connection to cylinders containing any other gas cannot be achieved (i.e. use of gas specific M.18 Connectors, for Nitrous Oxide). Non-return valves shall be fitted in the header, to eliminate leakage of gas when cylinders are removed from either bank. Flexible tailpipes shall be complete with cylinder connectors, for use with nitrous oxides, to suit the local supply of cylinders.
- N. The control panel shall automatically dispense the gas from one of the two cylinder banks (i.e. by changeover from 'duty' to 'reserve' cylinder bank). It shall be possible to select either bank of cylinders as the 'duty' bank. The changeover operation will be affected by gas pressure and will therefore be unaffected by any electrical failure.
- O. The pipeline pressure shall be controlled by the panel at 4.1 bar.

#### 2.11 ANAESTHETIC GAS SCAVENGING SYSTEM (A.G.S.S.)

- A. An anesthetic gas scavenging system, of the active type, shall be provided to extract and dispose of anesthetic gas mixtures from theatres; in accordance with the design requirements of this specification and as shown and scheduled on the drawings.
- B. The system shall be designed to meet the specification and performance criteria of BSEN 737-2 (1998) for disposal systems; and shall be compatible for use with transfer/receiver systems, manufactured to the same British Standard. Anesthetic gas scavenging system shall also comply with COSHH regulations.

- C. The anesthetic gas scavenging system shall comprise a packaged powered device, complete with vacuum/flow regulating valve, with air intake silencer, control panel, remote On/Off switches, terminal units (suitable for wall and pendant mounting, as indicated); together with powered device, discharge pipe and all distribution pipework.
- D. Powered devices shall be lateral channel vacuum pumps with impellers mounted directly on the shaft. Vacuum inlet relief valves shall be provided to prevent starvation of air to the units.
- E. The system shall be capable of providing a flow rate of between a maximum of 50 L/M (at 1 kPa resistance to flow) and a minimum of 25 L/M (at 2 kPa resistance to flow), at each terminal outlet irrespective of the number of terminal outlets, on stream.
- F. Each powered device shall be sized to suit the cumulative, simultaneous load of the system, for the number of outlets indicated on the drawings.
- G. Remote start On/Off switches located in each of the operating theatre control panels, shall activate the powered device and run the system.
- H. System static mode condition shall be achieved following disconnection/removal of probe(s), thus sealing the spring loaded nylon valve within the terminal outlet and switching the remote switch to its 'off' position.
- I. The system shall incorporate all electrical facilities, required to provide manual control of exhaustor units including all starter/isolators, overload protection and all necessary selector switches, contacts, control circuits and remote alarm facilities, including indication (if required).
- J. Vacuum/flow regulating valves shall automatically control the vacuum level in the pipework system and regulate the flow rate to terminal outlets. Silencer on the air intake side of regulating valves shall be provided.
- K. Terminal units for anesthetic gas scavenging systems shall be similar in appearance and size to those terminal outlets, previously specified for other medical gas applications; although AGSS terminal units shall be gas specific and non-interchangeable with similar type probes associated with other medical gas installations.
- L. The specialist installation Contractor shall carry out all testing and commissioning of the entire anesthetic gas scavenging system (AGSS), to ensure that the correct flow rate is achieved at every terminal unit, in accordance with B.S. 6834:1987, with one or all terminal units in use. Functional operational tests on powered devices shall also be carried out, to the satisfaction of the Engineer.
- M. In general, system proving tests and tests for proving correct connections, as applicable to medical vacuum system specified herein; shall be relevant to the anesthetic gas scavenging system.
- N. The works comprising the system design, selection and positioning of all plant and equipment, final pipeline sizing and routing, together with the full installation of the anesthetic gas scavenging system, shall be provided as a complete package by the specialist installation contractor, who must be conversant with the relevant safety standards of BSEN 737-2 (1998). The installation shall be carried out by M.B.I. /B.O.C., or equal approved. (N.B. The drawings issued with this specification, indicate the scope of the AGSS pipework system etc., but the final sizing and routing of service supplies shall be the responsibility of the specialist installation Contractor.)

## 2.12 MEDICAL GAS TERMINAL UNITS

### A. General

1. The Specialist Contractor shall supply and install outlet points at all positions indicated on the drawings and shall connect them to the appropriate service main.
2. Outlet sockets and connectors of each service shall be so designed that apparatus from any other service cannot be connected.
3. It shall not be possible by interchanging the component parts of outlet valves of one service to be wrongly fitted to the outlet base of any other service.
4. All medical gas terminal units shall comply with B.S. 5682:1984.
5. The flow rates required at terminal units shall be as required by HTM 02-01, Medical Gas pipe line systems (Design Consideration) 1994, Table 3.

### B. Wall Terminal Units

1. The medical gas terminal units shall be suitable for flush mounting where wall mounted or integrated into the bed head unit in ward areas. Refer to Architectural drawings for bed head unit details.
2. The units shall be easily serviced and incorporate a shut-off or secondary check valve, to isolate the unit and prevent gas flow during maintenance.
3. Each terminal unit shall be permanently imprinted with color coded gas identification labels and shall be provided with stainless steel cover plates.
4. The terminal unit shall be factory assembled to permit the installation of the wall boxes before the valves and cover plates. Protective plugs and covers shall be provided with each terminal unit to prevent plaster and other materials entering during the wall construction. Where outlets are to be installed in bed head units the outlets shall be supplied to the specialist bed head manufacturer for such coordinated inclusion.
5. The terminal units shall be labeled and supplied, clean, degreased and tested for the indicated services. Terminal units assemblies shall consist of three principle components:
  - a. A brass terminal block which shall be complete with a 12 mm diameter copper tail (approximately 200 mm long), suitable for connection to the pipe work system, using the flux less brazing technique described elsewhere in this specification.
  - b. A socket assembly, designed to accept a specific probe, with a clearly identified and indexed operating ring.
  - c. A concealed fixing housing unit/wall box, with stainless steel facia plate, unless mounted on bed head unit.
6. Where more than one service is provided at one location, the terminal unit shall be arranged in the following order, generally from left to right (or vertically from top to bottom in certain instances), viewed from operational side/facing the terminal unit.
  - Oxygen
  - Nitrous Oxide
  - Medical Compressed Air

- Surgical Compressed Air
- Medical Vacuum
- A.G.S.S

This order applies whether the individual terminal units are separate or form part of an assembly.

7. Terminal units in combinations of one, two, three or four services shall be finished with a flush fitting stainless steel fascia plate.
8. All components shall be packaged to offer maximum protection during transit and storage.
9. The services to each terminal unit shall be as indicated on the drawings. The Contractor shall be responsible for informing the Medical Gas Installation Contractor of the service required, at the Tender stage.

#### C. Bed Head Trunking System

##### 1. General

- a. The bed head trunking system shall be constructed from extruded aluminum sections with steel fascia panels faced with high-pressure laminate.
- b. All visible aluminum surfaces shall be powder coated offering a minimum guaranteed service life of 25 years.
- c. End caps shall be manufactured from 2.5mm thick UV stabilized and fire retardant high-impact Fabex 578. A removable UV stabilized polymer extrusion shall be provided to cover the fascia fixing screws and a tight seal to prevent dust traps.
- d. A UV stabilized elastomeric wall seal shall run the full length of the bed head unit, providing a dust tight seal between the upper surface of the trunking and the wall and shall cater for a 10mm tolerance in the flatness of the mounting surface.

##### 2. Medical Gases Compartment

- a. Three segregated service compartments shall run the length of the bed head unit to carry medical gas pipes, low-voltage electrical cables and ELV/data, with segregation of services being maintained throughout.
- b. Each bed head unit shall be supplied pre-piped, wired and certified. The design and configuration of the bed head units shall fully comply with all relevant applicable standards, including HTM 02-01, European, NFPA and ISO.
- c. The compartment for housing medical gas services shall be capable of running 3 pipes of 15mm diameter with axes on a common vertical plane to facilitate simple onsite brazing to the piped distribution system.

##### 3. Lighting

- a. The Trunking system shall be capable of taking UK Gem 10's, US Diamond III or other makes of medical gas terminal unit. Electrical sockets from UK, European and US or other types of socket may be fitted.
- b. Provision for nurse call, data or monitoring sockets shall be made at the point of manufacture. Trunking shall have the option of being supplied pre-piped, pre-wired and fully tested.

- c. Diffusers shall be manufactured from extruded fire retardant polycarbonate resin, incorporating prismatic inner surfaces to maximize efficiency of light distribution from the chosen source.
  - d. Luminaires shall be provided with electronic ballast's suitable for use with high efficiency fluorescent tubes.
  - e. Lighting controls shall be as agreed with the client and shall include options for local and/or remote control, control via the nurse call handset or control via a Digital Addressable Lighting Interface (DALI) or equivalent system.
4. Communications
- a. Provision for or fitting of the nurse call system shall be well coordinated by the bed head unit supplier.
  - b. Data sockets, including, but not limited to telephone sockets shall be installed in the bed head unit.
5. Medical Equipment Rail
- a. Medical equipment rails shall be designed in accordance with EN 12218:1999, manufactured from a hollow rectangular stainless steel profile of 30mm high by 10mm deep.
  - b. Provision for addition of further medical rails to the bed head unit after installation, without the need for power tools and without the need to disrupt the continuity of services, shall be made.

#### D. Ceiling Pendants

##### 1. Multi Movement Type

- a. Pendants shall be of the multi movement ceiling mounted type and shall be designed for use with concealed pipe work.
- b. A metal shrouded ceiling plate, rigidly secured to the ceiling shall support the pendant. The flexible pipes and electrical cables for the required services shall be within a support tube to terminate as gas terminal units and electrical sockets secured on the face of the housing.
- c. The Pendants shall be able to mount up to 14 medical gas/vacuum Terminal Units plus an Anesthetic Gas Scavenging Terminal Unit and 2 twin and 2 single (minimum) electric sockets/devices.
- d. Each terminal unit and socket outlet shall be identified with imprinted and color coded labels.
- e. For certain theater fittings, where terminal units having a circular arrangement is preferred (or required), the order shall be followed in clockwise direction viewed from below.

Terminal units incorporated in pendants shall be of a type suitable for mounting within the specified fittings, and shall not have the anti-rotational pin fitted.



- f. The multi-movement ceiling pendant shall be capable of limited lateral and vertical movement of limited range, (for lowest point) 1700 mm to 2200 mm FFL, in compliance with the N.H.S. Specification Document C11; and shall be factory assembled for the complete installation on bolts built into the ceiling structure.

The pendant shall also be labeled and supplied clean, with terminals and hoses and tested for the indicated services and shall be packaged to offer maximum protection during transit and storage.

- g. The services to each pendant shall be as indicated on the drawings. The Contractor shall be responsible for informing the pendant manufacturer of the services required and the ceiling height at the Tender stage.

## 2. Rigid Type

- a. The rigid type ceiling pendant shall comply with the specification clauses previously defined, for multi-movement pendant; but the following deviations shall apply:
- b. Pendants shall be of rigid type ceiling mounted and shall be designed for use with concealed pipe work.
- c. The Pendants shall be octagonal in section and be able to mount up to 14 medical gas/vacuum Terminal Units plus an Anesthetic Gas Scavenging Terminal Unit and 2 twin and 2 single (minimum) electric sockets/devices.
- d. Rigid pendants shall be manufactured using solid copper pipe work to feed the Terminal Units in accordance with BS EN 793. Medical gas/vacuum services shall incorporate Gem 10 terminal units and anesthetic gas scavenging disposal system shall incorporate terminal unit in accordance to BS6834: 1987 and BS EN 737- 1: 1998.
- e. Rigid pendants shall be manufactured and installed to provide a specified clearance above finished floor level. The pendant shall incorporate Medical gas/vacuum and electrical services as specified by the Engineer and shall be located as per HTM 02-01 recommendations.
- f. Medical gas/vacuum services shall be arranged in accordance with HTM 02-01 and NHS Code C 11 recommendations. Electrical installations shall conform to IEE regulations, routed through flexible conduit and terminate in a junction box.
- g. Rigid pendants shall be manufactured with an 'easy clean' high quality powder paint. All stainless steel surfaces are satin finish and non-reflective. All Pendants shall have a soft bumper strip around the bottom edge.

## 2.13 WARNING AND ALARM SYSTEMS

### A. Extent of Work

- 1. The specialist contractor shall supply and commission all necessary warning and alarm systems associated with the medical gas installations at the hospital, comprising a combination of visual flashing lights and audible

alarms, in accordance with the UK's National Health Service - Model Engineering Specification C11, dated January 1990.

2. Display units shall be provided where specified, shown on the drawings or as required by the Engineer to give routine indication that the medical gas services have changed over from "Normal" to "Standby" conditions, to indicate that a plant/system malfunction has occurred and the supply is threatened, that system pressures are out with specified parameters (i.e. high, low and line pressure faults) or that reserve supplies are in use.
3. The warning and alarm systems shall comprise:
  - a. A five gas, central alarm panel installed in a 24 hour manned location as marked on drawing to monitor all the plants supplying:
    - Oxygen
    - Nitrous Oxide
    - Medical Vacuum
    - Medical Compressed Air
  - b. Repeater panels to repeat the information displayed on the central alarm panel; located in the main service building control room.
  - c. Area alarm panels (A.A.P.) to indicate pressure variations on medical gas systems, shall be located within:
    - Each O.R./Theater control panel
    - Recovery areas
    - I.C.U.'s
    - At each nurses station
    - All treatment area, etc. as shown on drawings

The Contractor shall refer to the schedule of area alarm panels with appropriate medical gas services provisions, as appended to this specification document, as a general guideline, as well as consulting the contract drawings for their approximate locations. It shall be the specialist contractor's responsibility to ensure that full building coverage is provided with respect to warning and alarm system indication.
  - d. Area alarm repeater panels shall be located in each of the O.R. superintendent's office. Each repeater panel shall provide visual and audible signal for change of state on any medical gas supply to each theater. The general layout of these repeater panels shall be similar to the area alarm panels. Labeling of the alarm condition shall read "Medical Gas Pressure Fault".
  - e. The central medical gas alarm panel shall also register fault indication from area alarm panels and repeater panels located throughout the building.
4. Medical gas warning and alarm system displays at area alarm panels, shall indicate the prevailing conditions on each service, sensed after the A.V.S.U. and shall display to the system user (in that area), the occurrence of high or low gas pressure.
5. The specialist Contractor shall submit with his tender bid, his full proposals, in respect of the warning and alarm systems for the PMG & V installations.

**B. Central Alarm Panel/Area Panels**

1. The central alarm system shall be capable of monitoring all medical plants and manifolds, and individual area or point alarms fitted within the hospital

installation; and shall be a fully integrated multiplexed system employing "state of the art" technology.

2. The alarm system shall be totally flexible, with facilities for individual programming of the circuits during manufacture and be capable of system adjustment and fine tuning by on-site reprogramming, to suit system updates, enhancements or extensions thereof.
3. The central alarm panel may comprise multiple units, interconnected to give a modular assembly. The modular architecture shall be so designed (bus-based) as to facilitate future upgrades or repairs.
4. The central alarm panel shall have facilities to display the specified gas services in the "normal" and "4 stage" alarm condition, as required by specification C11. Display indicators shall be arranged vertically in order of priority, with the "normal" indicators at the top.
5. Colored visual displays shall be provided by LED's with a minimum design life of 5 year continuous use. Each LED indication shall incorporate 2 individual LED's connected in parallel, to provide duplex circuits, separately energized, whereby failure of one will not affect the other and the loss of either will be clearly evident.
6. Each gas display column shall be capable of displaying 5 individual point alarms and when interconnected with the area alarm panels, shall be capable of identifying and displaying, specific gas services as point alarms.
7. Inputs, from respective medical gas supply systems shall enter the alarm system at the nearest area alarm panel, thereafter information shall be transmitted for display throughout the system, by means of a data transmission circuit of suitable design and materials such that it shall be protected against external interference with the signals and physical damage.
8. The central alarm panel installation shall incorporate status and alarm displays, comprising the following:
  - a. Power on indication steady light.
  - b. System alarm indication flashing light.
  - c. Mute selector switch.
  - d. Test selector switch.
9. The system alarm indication shall display the prevailing condition of each service sensed at the plant location.
10. Audible warning programs to operate in accordance with specification C11 shall be provided, together with a "mute" facility. A maintenance "mute" facility shall also be provided, to automatically reset the system, when the gas service returns to "normal".
11. The specialist Contractor shall provide appropriate interfaces, for interconnection of the central medical gas alarm system and the Building Management System (BMS). This facility shall only provide status indication to the BMS of the medical gas system; it shall not allow the BMS to control any of the medical gas systems.
12. Facilities shall be provided at each alarm panel to indicate that the electrical power is available displayed through a green indicate and an "Alarm System Fault" shall indicate if the self interrogation circuits detect a

fault, displayed through a red indicator, via the plant to alarm interface unit within the respective alarm panel.

Colors of LED's used for indication must be

- Red : Gas alarms
- Green : Normal status/electric power on
- Yellow : System fault

13. Line monitoring circuits shall be provided to constantly monitor the integrity of service, failure of pressure sensors and interconnecting wiring.
14. In the event of a fault in gas supply the following signals shall be indicated
  - Gas service failure
  - Alarm indicating fault
  - Audible warningThese signals shall be indicated in both the central and area alarm panels.
15. Additional system fault diagnostic procedures shall be provided with the equipment, including variation of flashing rate on LED's under test conditions etc.
16. In the event of an electrical power supply failure, the "Alarm System Fault" LED shall be illuminated and an audible warning given, via the unit's standby battery power source; for a minimum period of 4 hours, with an automatic re-charge time of 72 hours maximum.
17. Central alarm panels and area panels etc. shall provide all display and alarm functions required by specification C11.

#### C. Working of Central and Area Alarm Units

1. The units shall indicate the condition of all the monitored services simultaneously.
2. The audible alarm on each unit shall be common to all services and be arranged to re-set automatically after being muted, or if muting is not carried out, after the fault is rectified.
3. When an alarm condition arises the appropriate lamps on the central and area alarm units shall flash and the audible alarms (if present for the alarm condition) shall sound. All flashing lights shall be converted to steady indication by the muting switch on the central unit, and the audible alarms on area alarms units, shall only be muted by their own individual muting switch. The muting switch shall deal with only one alarm at once, and if a further alarm condition arises, the appropriate lights shall flash and the audible alarm shall sound until the muting switch is operated again.
4. The alarm system shall automatically reset when conditions return to normal even if this occurs before any of the muting switches are operated.
5. The test buttons shall only test the alarms on the unit which contains the test button.
6. The specialist contractor shall supply, install and commission the display units. The interconnection and wiring of the units will be carried out by the Electrical sub-Contractor.
7. Alarm panels shall be designed as safety extra low Voltage (SELV) systems or as functional extra low voltage (FELV) systems, as defined in part 4 of the latest edition of NEC. Wiring Regulations.

D. Arrangement of Panels on Units

1. The order in which the services shall be arranged on the central and area alarm panels shall be that adopted for terminal units, i.e. when facing the panels the service shall be in the following order reading from the left to right:

Oxygen, Nitrous Oxide, Medical Compressed Air, Vacuum.

2. Alarm panels generally shall be arranged for access to the interior by means of tamper-proof fitting, supplied by the specialist installation Contractor.

E. Engraving of Fascia Panels of Units

1. The front covers of all units shall incorporate hinged, flush mounted fascia of dark anodized aluminum or dark polyester to highlight the display windows. Displays shall be illuminated by colored LED block indicators and have captions to indicate the gas service.

2. The alarm panels shall also incorporate a green LED to indicate that the electrical power supply is on, and a red LED to indicate a gas alarm.

3. Gas service legends shall be suitably identified and the correct combination shall be fitted to satisfy the requirements of each location, in compliance with specification C.11.

4. Alarm panels shall be clearly and legibly labeled to indicate:

- a. Medical Gas Alarm
- b. Gas Service Name(s)
- c. Individual System Condition
- d. The functions of the various press buttons and switches

5. Alarm panels shall be installed, as either a surface or concealed installation, to suit the Ministry Representative; be resistant to corrosion and have electrical sections at least to I.P. 32 protection standard in accordance with BS 5490.

F. Monitoring Equipment

1. The specialist Contractor shall include for supplying and fixing all necessary sensing devices, operating switches and relays on the equipment for the initiation of the warning and alarm signals; in accordance with specification document C.11 dated January 1990.

2. Reliability and long life of contacts in relay units shall be an essential feature of the equipment.

3. The relays shall be energized under normal operating conditions and the alarm contacts shall be volt-free with minimum ratings of 50 V d.c. 50 mA.

G. Setting of Sensing Devices

1. The sensing devices shall be set so that the conditions listed in the applicable section of specification C11 are indicated as soon as they exceed the stated limits.

These shall include all alarm system initiating devices, alarm line fault monitoring devices, signal contacts, etc.

2. The Contractor shall ensure that auditory signal tone and reinstatement provisions, system integrity and illumination facilities etc., associated with all medical gas warning and alarm systems, comply with specification document C.11 dated January 1990.

H. Electrical Wiring

1. The interconnecting wiring shall be carried out by the electrical contractor but the specialist Contractor shall supply all necessary wiring diagrams, such quantity and format as needed for the Contractor's and Electrical Contractor's own use and for transmittal for review and approval.

I. Specifications of Alarm Cable

1. The Electrical Contractor shall use special data transmission cable, as recommended or required by the Specialist Contractor, responsible for the Medical Gas Installation, in compliance with this specification.

J. Central Alarm Panels and Repeater Panels:

1. Alarm panels shall display the undernoted conditions:
  - a. All emergency conditions
  - b. All pipeline distribution system pressure faults
  - c. All plant faults
  - d. All alarm system faults
  - e. All plant/alarm system interface faults
2. Under alarm conditions the auditory signal shall operate, the "Normal" status the indicator will be off and the corresponding alarm signal indicator will flash.
3. Central alarm panels shall be able to cancel the auditory signal (for the current alarm conditions) via a mute switch, with simultaneous change from flashing to steady illumination of corresponding indicators on the panel.
4. On cancellation of auditory signal on repeater panels, the indicator shall continue to flash until changed to continuous illumination, by the operation of the mute switch on the central alarm panel.
5. All alarm panels (i.e. central, repeater and area alarm panels) shall be arranged for subsequent alarm conditions to initiate the appropriate indicator and sound the necessary auditory signal.

K. Area Alarm Panels

1. Area alarm panels shall display the "Normal" or "Fault" condition of the relevant medical gases, after the final area valve service unit (A.V.S.U.).
2. Under alarm conditions, the alarm panels shall operate the alarm auditory signal, discontinue the "Normal" status indication and flash the corresponding alarm indicator. Operation of the local mute switch shall cancel the auditory alarm; but the flashing indication shall continue until the alarm condition is removed.

Note: Within area alarm panels located within the operating theaters, provision shall be incorporated, to provide a combined pressure fault condition, to be relayed to a corresponding repeater panel located within the theater superintendent's office(s).

L. Schedule - Central Panel Legend and Display

PLANT	ALARM CONDITION	LEGEND	COLOR	AUDITORY SIGNAL
1. Automatic Manifolds				
i. Oxygen Manifold	a. Duty bank empty changeover to standby bank	CHANGE CYLINDERS	Yellow	Yes
	b. Standby bank below 14 bar nominal	CHANGE IMMEDIATELY	Yellow	Yes
	c. Emergency manifold in operation.	REMOVE FAULT ON NORMAL MANIFOLD	Yellow	Yes
ii. Nitrous Oxide Manifold	a. Duty bank empty changeover to standby bank	CHANGE CYLINDERS	Yellow	Yes
	b. Standby bank below 14 bar nominal	CHANGE IMMEDIATELY	Yellow	Yes
	c. Emergency manifold in operation.	REMOVE FAULT ON NORMAL MANIFOLD	Yellow	Yes
2. Medical Air Plant	a. Plant Fault b. Plant Emergency c. Emergency manifold in operation.	a. PLANT FAULT b. PLANT EMERGENCY c. PLANT EMERGENCY	Yellow	Yes
3. Surgical Air Plant	a. Plant Fault b. Plant Emergency	a. PLANT FAULT b. PLANT EMERGENCY	Yellow	Yes
4. Medical Vacuum Plant	a. Plant Fault b. Plant Emergency	a. PLANT FAULT b. PLANT EMERGENCY	Yellow	Yes
5. Anesthetic gas scavenging	a. Plant Fault b. Plant Emergency	a. PLANT FAULT b. PLANT EMERGENCY	Yellow	Yes

M. Schedule - Central Panel Legend and Display (Cont'd)

PLANT	ALARM CONDITION	LEGEND	COLOR	AUDITORY SIGNAL
6. Pressure Fault (Pipeline)	For each gas service to Indicate that the pressure in the distribution system is either above 503 KPa nominal (529-478 KPa operating tolerance) or below 412 KPa nominal (432-391KPa operating	RESERVE FAULT	Red	Yes

7. Vacuum Pressure (Pipeline)	tolerance) 3 a. To indicate that the vacuum in the pipeline serving the department has fallen below 420 mm Hg nominal (440-400 operating tolerance)	RESERVE FAULT	Red	No
-------------------------------	---	---------------	-----	----

N. Schedule - Area Alarm Panel Legend and Display

ALARM FUNCTION	LEGEND	COLOR	AUDITORY SIGNAL
1. For each gas service to indicate that the pressure in the pipeline serving the department has risen above 503 KPa nominal(529-478 KPa operating tolerance)	HIGH PRESSURE	Red	Yes
2. For each gas service to indicate that the pressure in the pipeline serving the department has fallen below 373 KPa nominal (392-354 KPa operating tolerance)	LOW PRESSURE	Red	Yes
3. For vacuum to indicate that the vacuum in the pipeline serving the department has fallen below 370 mm Hg nominal (390-350 KPa operating tolerance)	PRESSURE FAULT	Red	Yes

2.14 DUPLEX TYPE OXYGEN GENERATING PLANT (NOT USED)

A. General

1. A Duplex type Oxygen Generating Plant shall be required for producing high purity oxygen, the plant shall be based on Pressure Swing Adsorption (PSA) technology. The flow rate and pressure rating of oxygen generating plant shall be as such that meets the maximum flow and pressure requirement of the hospital with purity of oxygen at 93 % ( $\pm 3\%$ ). The manufacturer shall also ensure that the produced oxygen is free of any trace of pollutant (CO, CO<sub>2</sub>, oil, etc.), in compliance with the United States Pharmacopeia (USP) XXII Oxygen 93% Monograph as well as European and other Pharmacopeia.
2. The full installation shall include all required support equipment like air compressor, air-dryer, air filter, air receiver tank, oxygen generator, oxygen generator controller, oxygen receiver tank, low pressure oxygen booster and a bottle refilling station.



## B. System Components

The system components for oxygen generating plant shall comply with the specification clauses previously defined, for the medical compressed air system; but the following deviations shall apply:

1. Air Compressor  
The compressor shall be of rotary screw type equipped with air cooler and after cooler. The compressor shall be designed and manufactured according to the following standards:
  - Performance: ISO 1217 edition 3 annex C of 1996.
  - Quality: ISO 9001.
  - Environment: materials and components ISO 14001.
  - Motor efficiency: EPACT.
  - Machines and Separators: EC and Developing Countries.
2. Air-dryer  
Refrigerant air-dryer shall be equipped with set of oil separator filters of 0.01  $\mu$  and anti dust filters of 1  $\mu$ . The Refrigerant air-dryer shall use a refrigerant R 407 or of a type approved in the CE.
3. Air Receiver Tanks  
Vertical Air Receiver tanks shall be equipped with all safety accessories with galvanized interior and exterior construction.
4. Oxygen Generators / Concentrator  
Oxygen generators shall be of 2 molecular sieve beds construction with Set of electro-pneumatic valves, Zirconium Oxygen Analyzer with automatic shut down in case of low purity, Ergonomic command & control including PLC with touch-screen having display of 5.7 inch for displaying:
  - Oxygen Purity
  - Output pressure
  - Alarms reporting and interface
  - Maintenance Mode
  - Historical Data
  - Remote control Mode
5. Oxygen Generator Controller  

Oxygen Controller shall comprises of a PLC and a high definition color touch screen panel that can be able to automatically control and monitor the oxygen generator package. Oxygen purity and pressure shall be displayed on the screen and can be recorded 24h/24 on SD Card. This oxygen generator controller shall also be able to be alarming management system and shall be capable of drawing historical trending curves. The controller can manage permutations between two oxygen generators and can be remotely controlled through Internet, Smart phones or specific hospital data networks and shall be user friendly with availability to operate in English language.

In addition to above mentioned controller a lateral process control panel is also required that gives access to a direct reading of the main pressure parameters of the oxygen generating process, along with an innovative calibration system which guarantees the accuracy of the oxygen purity measurement.

6. Oxygen receiver tanks

Vertical Oxygen receiver tank shall be capable of holding medical grade oxygen and shall be of galvanized interior and exterior construction equipped with all related safety accessories.

7. Low pressure Oxygen Boosters

Low pressure oxygen boosters shall be capable of boosting the line pressure. The capacity of oxygen boosters shall be selected in a way that meet the maximum flow and pressure requirement of the Hospital. The boosters shall be equipped with all accessories and interconnections in compliance with ISO 10083:200, USP 93 and new European Pharmacopeia Oxygen 93%.

8. Bottle Refilling Station

The plant shall also be supplied along with a bottle refilling station for 1 to 10 cylinders per day of standard sizes. The bottle refilling station size shall be based on maximum number of high pressure, 6 m<sup>3</sup> size (K or H-size) oxygen cylinders the plant can fill in 24 hours. Bottle refilling station shall include all the support equipment required and shall be factory tested and preferably skid mounted.

2.15 *VACUUM INSULATED EVAPORATOR (VIE) SYSTEM* **(NOT USED)**

A. General

1. The purpose of a Liquid Oxygen Supply System is to provide a reliable and constant source of medical quality gaseous oxygen and complying with the requirements of relevant latest codes and standard. A VIE plant for bulk liquid oxygen is required as a primary source of supply that shall comply to HTM 02-01 and C 11 requirement. The storage capacity of the VIE tank shall be at least 14 days' consumption of the hospital with an emergency backup supply equivalent to 24 hours average use, at a pressure of at least 10.5 bar along-with a telemetry system to monitor gas usage.
2. The full installation of a Vacuum insulated evaporator (VIE) shall include but not limited to, a vacuum insulated tank to store the bulk liquid at appropriate operating pressure, a pressure raising system to maintain VIE operating pressure, a vaporizer system to convert liquid into gaseous product at ambient temperature and a telemetry system to monitor gas usage taking into account of the demand, peak consumption and site location.
3. The liquid Oxygen Supply System shall be installed in an outdoor area dedicated for the purpose built and secure compound as indicated on drawing.
4. The system supplier should ensure oxygen compatible material is used for oxygen supply system which comes into contact with the medical oxygen gas under operating conditions. The specific hazards of toxic products of combustion or decomposition from non-metallic materials (including lubricants, if used) and potential contaminants should be addressed. Design considerations to mitigate the potential risks of toxicity when using non-metallic materials in high pressure oxygen breathing systems shall be strictly followed.

B. System Components

The system components for VIE System shall comply with the specification clauses previously defined, for medical compressed air system; but following deviations shall apply:

### 1. Vacuum Insulated Tank

The VIE inner vessel shall be designed, constructed and certified in accordance with BS 5500, Category 1 and as per ASME specifications. The outer vacuum jacket shall be designed and constructed as per manufacturer process plants standards and protected to withstand the most severe weather conditions. The space between the inner and outer walls shall be filled with granular expanded perlite and evacuated to a high vacuum providing a minimum of evaporation loss.

### 2. Pressure Raising System

An integral control circuit shall incorporate a pressure-raising coil, economizer valve, relief valves and bursting discs for maximum safety. Operation of the VIE shall be completely automatic. Vessel, valves and associated pipe work shall be degassed for oxygen service and finally pressurized with dry nitrogen to 0.2 Bar prior to dispatch. A check valve or trap in the discharge line shall be provided to prevent hazardous back flow into the system.

### 3. Vaporizing System

A matches system of Vaporizers heated by ambient air shall be fitted in place to ensure that maximum design flow rates are maintained. An Emergency Standby Manifold shall be required along with controls to ensure that continuity of supply is maintained in the event of the liquid supply failure. All necessary Pressure Regulators to provide 410kPa (4.1 bar) at the distribution system and a pressure relief valve set at 534 kPa (5.34 bar) shall be required to control the internal pressure by venting periodically. Pressure relief devices must be provided in lines where there is the potential to trap liquid between valves.

### 4. Telemetry System

A Volt free "normally closed", terminals shall be required to enable connection of a remote alarm system which operates in complying with HTM 02-01 and C11 logic. A remote alarm system shall constantly monitor the supply system and shall operate in accordance with HTM02-01 and C11.

## 2.16 *PORTABLE MEDICAL GASES ANALYZER (NOT USED)*

Requirement of a portable **analyzer for medical gasses** to control the medical catches in different areas of hospital is envisaged. It shall function on battery with greater than 100 hours backup. It shall be able to measure O<sub>2</sub> level from 0 to 100% with an accuracy level of  $\pm 1\%$  providing a digital display. The equipment shall be able to perform satisfactorily within a temperature range of +5 °C to +40 °C and allow to realize the mechanical control of the catches located in the rooms, the measurement of the nature of gas (O<sub>2</sub>, Air, N<sub>2</sub>O etc...) and the **measurement of pressure** (vacuum to +10 Bar) and shall be conforming to EN ISO 7396-1. It shall be able to quickly perform following tests:

- Control of the mechanic catches on the wall (at the head of bed).
- Control of the nature of gas by analysis of O<sub>2</sub>.
- Control of pressure, vacuum to +10 bar.

## 2.17 *NITROUS OXIDE AND OXYGEN MIXER CYLINDER WITH APPARATUS (NOT USED)*

Nitrous oxide/oxygen mixture shall be used to provide pain relieving with the benefits of additional oxygen without producing unconsciousness. It shall be used analgesic for acute, short-term pain relief in a diverse range of clinical situations, from painful procedures to childbirth.

Nitrous oxide/oxygen mixture shall be administered through a facemask or mouthpiece. The face mask or mouthpiece shall be connected to an Nitrous oxide/oxygen mixture supply through a demand valve system that allows the Nitrous oxide/oxygen mixture to be self-regulated by the patient. The demand valve shall be operated by the act of inhalation of the patient and closes down when the patient ceases to inhale.

The Nitrous oxide/oxygen mixture (50% Oxygen: 50% Nitrous Oxide) system shall be supplied with following essential accessories:

- i. An integrated pressure regulator, eliminating the need of fitting separate regulators.
- ii. Easy on/off hand wheel operation for safety and time saving.
- iii. A "live" contents gauge, indicating contents level even when the cylinder is turned off.
- iv. A demand valve system
- v. Silicone Hose up-to 4 meters in length.
- vi. Facemask / mouth piece (at least 05 Nos.)
- vii. Capacity of cylinder shall be at least 350 liters for providing approximately 58 minutes of pain relief. (Based on average adult consumption rate i.e., 6 l/m).
- viii. The medical oxygen specification shall comply with the current European Pharmacopeia monograph (0417).
- ix. The nitrous oxide specification shall comply with the current European Pharmacopeia monograph (0416).

### PART 3 - EXECUTION

#### 3.1 GENERAL INSTALLATION

- A. All necessary work, cleaning, testing and adjustments shall be carried out on behalf of the contractor by a special subcontractor competent in the execution of such works to the standards and certification required by HTM 02-01 and in accordance with the specification.
- B. Do not lubricate any tools used for medical gas pipe fabrication with oil or grease under any circumstances.
- C. Do not use carbon tetrachloride for re-washing under any circumstances.
- D. Where any section of the pipe is left incomplete for any purpose, the pipe shall be securely sealed with purpose made plastic blocking caps.
- E. All brackets, clamps or other fixtures attached to medical gas piping shall be made of non ferrous material or provided with a suitable coating to prevent electrolytic corrosion and shall be manufacturer's standard products.

#### 3.2 IDENTIFICATION

- A. Identification of Pipelines and Terminal Units
  1. Pipelines shall be identified in accordance with the scheme existing in AFH using color banding for the pipelines outside the plant rooms. Where color bands are used the identification shall be applied near to valves, junctions, wall etc. Each gas shall be identified in 6 mm letters. Self adhesive plastic labels may be used for this purpose. All color coded tapes applied by the pipe manufacturers shall be removed before the systems are identified.

2. Terminal units shall be identified by labeling with the appropriate recognized name, abbreviation or symbol as follows:

Oxygen	:	White
Nitrous Oxide	:	French Blue British Standard Color 166
Medical Compressed Air	:	White/Black quartering
Medical Vacuum	:	Primrose, British Standard Color 354

3. The coloring as indicated in H.T.M. No. 02-01, the name and the color shall be permanent and it shall be impossible to transfer either to a terminal unit for a different gas.
  4. By 'permanent' it is meant that the name should be etched, indented, raised or otherwise made comparatively indestructible and that the colored part shall be made of colored plastic, enamel or similar material, not painted.
- B. Labels: Traffolyte or similar material shall be used for identification labels, engraved with black lettering on appropriate background colors except where otherwise specified.
- C. Painting: All bare metalwork, brackets, supports etc., where initially untreated shall be wire brush cleaned and suitably undercoated with a rustproof solution and painted with two coats of good quality heat resisting paint.

### 3.3 TESTING

#### A. General

1. The Contractor shall carry out all tests specified in HTM 02-01 and all defects must be corrected before any pipe work or other parts of the installation are concealed. This will required tests to be carried out in sections as the building work proceeds.
2. The Specialist Contractor shall provide all labor, materials instruments and equipment required to test and commission the installation. If there is any reason to doubt the accuracy of the instruments the Specialist Contractor shall, at his own expense, take the necessary steps to prove their accuracy.

#### B. Access for Testing

1. Where pipe work is concealed within ceiling voids, removable access tiles will be left unfitted and will not be finally fitted until the pipe work installation has satisfactorily passed the specified pressure or vacuum tests.
2. Where copper pipes pass through walls, partitions or floors, they shall be inserted through copper sleeves which shall conform to B.S. 2871 and shall be fitted where appropriate with wall or ceiling plates.

#### C. Purging

1. On completion the pipelines shall be purged with medical quality compressed air to remove particulate matter and residual Nitrogen.
2. The pipeline shall be pulse purged or otherwise vibrated during purging to ensure the dislodgment and purging of particulate matter.

#### D. Tests

1. On completion of purging the following cleanliness tests shall be carried out:

- a. Test for particulate matter

Tests for particulate matter shall be carried out at normal working pressure and using a flow control device which will limit the test flow to 1.5 times the designed maximum flow through the terminal unit being used for the test. For example, for oxygen terminal unit the flow should be 60 liters/min at a nominal pressure of 4 bar. During this test, the distribution system including branches and mains shall be operated in a manner which ensures that the diversified design flow is similarly increased by 50%.

Currently, a 0.8u millipore type filter should be used in association with the flow control device.

The millipore filter should show no visible particles when tested under the above conditions for 1 minute.

- b. Test for Nitrogen

With adequate purging, residual carbon dioxide or Nitrogen is unlikely to be present in a pipeline system. Every terminal unit shall be tested to ensure removal of N<sub>2</sub> and positive test for N<sub>2</sub> concentration shall be carried out on at least one terminal unit on each branch. Tests to establish the removal of N<sub>2</sub> may be carried out during tests to establish freedom from particulate matter. The Suitable Qualified Person will be involved.

2. Once purging has been satisfactorily completed the system (or part thereof) shall be charged with medical quality compressed air and maintained in this condition until Practical Completion of the Works.

#### E. Testing and System Proving Generally

1. All manifolds, compressors, air dryers, vacuum pumps, etc., shall have passed the appropriate tests at the manufacturer's works and certificates indicating performance and sound pressure levels shall be made available in good time.
2. The following procedure shall be satisfactorily completed towards the end of the construction period and before the installation is formally handed over.
3. It is envisaged that this procedure will have to be repeated just prior to occupation as this is usually much later than the actual handover date.
  - a. Check Test pressure loss in pipelines.
  - b. Check valve tightness and correct valve zoning.
  - c. Check safety valve operation.
  - d. Check pressure loss in complete installation.
  - e. Check for satisfactory mechanical operation and non interchange ability of each terminal unit.
  - f. Check for cross connections (sometimes referred to as anti-confusion tests).
  - g. Check flow rate and pressure at each terminal.
  - h. Check total flow rate and delivery pressure.
  - i. Check satisfactory operation of manifold changeover valves.

- j. Check satisfactory operation of all plant and delivery systems including any emergency cylinders.
  - k. Check performance of alarm system.
  - l. Purge the complete installation with medical air and check internal cleanliness.
  - m. Purge the complete installation with the working gas.
- 4. The above tests shall be carried out in accordance with HTM 02-01 or in accordance with the following specification. The H.T.M. No. 02-01:2006 shall be considered as the most important guide to the testing of the installations and shall only be supplemented by the clauses of this specification.
  - 5. The specialist installation Contractor shall carry out all tests specified and all defects must be corrected before any pipe work or other parts of the installation are concealed. This may require tests to be carried out in sections as the building work proceeds; allowance must be included for this in the tender.
  - 6. The specialist installation contractor shall provide all labor, materials, instruments and equipment required to test and system prove the installation. If there is any reason to doubt the accuracy of the instruments the specialist contractor shall, at his own expense, take the necessary steps to prove their accuracy to the Owner's Representative.

F. Pressure Tests on Medical Gas and Compressed Air Pipe work

The following tests and procedures shall be carried out on all pipe work for medical services, by the Specialist Installer in the presence of the Engineer.

- 1. Pipeline first fix pressure tests to be carried out with plant disconnected and prior to fixing of socket assemblies, theater fittings, relief valves or pressure switches.
- 2. Cap or plug off all the pipe terminations and pressure test the first fix pipe work with compressed air, which the Contractor shall supply, at twice the working pressure. The air shall be oil free and have a dew point temperature not higher than -40 degrees C, at atmospheric pressure.
- 3. With the compressed air supply disconnected and with all pipeline valves open, this pressure shall be maintained in the pipeline for a period not less than 24 hours. During this period no leaks shall occur.
- 4. Should the pressure not be maintained as above, the Contractor shall detect any leaks by the use of a soap solution applied externally to all joints, glands and connections.
- 5. All leaks shall be made good by the Contractor by remaking the affected joints and the foregoing pressure tests repeated until the standard specified has been attained.
- 6. On completion of the pressure test all isolating and zone valves shall be tested for tightness by closing them in sequence and releasing the pressure on the downstream side. No leaks shall occur during the valve tests.
- 7. Each valve tightness test shall be held for not less than 15 minutes.
- 8. Care shall be taken to ensure that all valves on main and sub-main branches of the pipe work are properly subjected to this test.

9. All second fix items including factory set pressure relief valves and pressure switches etc., shall be reconnected to the system.
10. The following shall then be carried out in the order shown:
  - a. Connect the outlets and theater fittings.
  - b. Purge the system with compressed air.
  - c. Pressure tests the complete system at the working pressure and rectifies any possible leakages at the outlets.
  - d. Connect the plant.
  - e. Demonstrate the system and prove correct connections to all outlets and theater fittings to the gases in accordance with the drawings, schedules and specifications.

G. Medical Vacuum Pipe work (Pressure Tests)

1. The following test shall be carried out by the specialist installer, in the presence of the Engineer.
  - a. Pipeline first fix pressure tests shall be carried out with the vacuum plant disconnected and prior to fixing of vacuum outlets, theater fittings and pressure switches.
2. Cap or plug off all the pipe terminators and pressure test the first fix pipe work with compressed air at 7.8 bar g. With compressed air supply disconnected and with all pipeline valves open, this pressure shall be maintained in the pipeline for a period of not less than 24 hours. During this period no leaks shall occur.
3. Should the pressure not be maintained, the Contractor shall detect any leaks by the use of soap solution applied externally to joints, glands and connections. Any such leaks shall be made good by remaking the affected joints.
4. With all vacuum outlets, theater fittings and plant connected, the system shall be exhausted down to a vacuum of 210 mm Hg absolute, for a period of 24 hours pressure rise in the pipe work shall not exceed 1 mm Hg per hour. A pressure rise in excess of 1 mm Hg per hour shall indicate the need for remedial work and further tests.

H. Valve Shut-Off Tests

1. On completion of the pressure tests all isolating valves shall be tested for tightness by closing them in sequence and releasing the pressure on the downstream side (assuming flow to the outlet for the purpose of this test). No leaks shall occur during these valve tests. Care must be taken to ensure that all valves on main and sub-main branches of the pipe work are properly subjected to this test.

I. Tests for Proving Correct Connections to Medical Gas and Compressed Air Outlets and Vacuum Points:

The following tests and procedures shall be carried out by the specialist installer, in the presence of the Engineer and the nominated representative of the Hospital Authority.



Demonstrate the correct connections of all outlets points and surgical unit fittings to the gases specified on the drawings and in the specifications.

Where more than one piped medical service is installed, e.g. Oxygen, Nitrous Oxide, Compressed Air and Vacuum, the following procedures shall be carried out, using the Medical Quality Compressed Air gas in each case:

1. Oxygen
  - a. Isolate all other services supply from the distribution pipe work (i.e. O<sub>2</sub>, N<sub>2</sub>O, Medical C.A. and Vacuum Plant).
  - b. Connect the Oxygen. Charge the system with Medical C.A. leave on line.
  - c. Check that the outlet point is correctly marked and coded and that 40 LPM of gas flow is maintained at each outlet with a pressure of 4 bars. The working pressure must be maintained during this test.
  - d. Check that there is NO FLOW at any other services points (i.e. N<sub>2</sub>O, Medical C.A. and Vacuum outlets).
  - e. Release the Medical C.A. pressure, "valve off" and isolate from Oxygen line.
2. Nitrous Oxide
  - a. Isolate all other services supply from the distribution pipe work (i.e. N<sub>2</sub>O, O<sub>2</sub>, Medical C.A. and Vacuum Plant).
  - b. Connect the Nitrous Oxide. Charge the system with Medical C.A. and leave on line.
  - c. Check that the outlet point is correctly marked and coded and that 40 LPM of gas flow is maintained at each outlet with a pressure of 4 bars. The working pressure must be maintained during this test.
  - d. Check that there is NO FLOW at any other services point (i.e. O<sub>2</sub>, Medical C.A. and Vacuum outlets).
  - e. Release the pressure, "valve off" and isolate from the Nitrous Oxide pipe work.
3. Medical Compressed Air (4 bars)
  - a. Isolate all other services supply from the distribution pipe work (i.e. N<sub>2</sub>O, O<sub>2</sub>, Vacuum plant).
  - b. Connect the Compressed air. Charge the system with Medical C.A. and leave on line.
  - c. Check that the outlet point is marked and coded and that 50 LPM of Compressed Air Flow is maintained at each outlet with a pressure of 4.1 bars. The working pressure must be maintained during this test.
  - d. Check that there is NO FLOW at any other services point (i.e. O<sub>2</sub>, N<sub>2</sub>O and Vacuum points).
  - e. Release the pressure, "valve off" to the distribution system.

4. Medical Vacuum

- a. Isolate all other services supply from the distribution pipe work (i.e. Medical C.A, O<sub>2</sub> and N<sub>2</sub>O systems).
- b. Connect the vacuum plant to its distribution pipe work.
- c. With the vacuum plant operating, check that the designed rate of flow 40 L/M of free air when vacuum in the system is 450 mm Hg gauge is maintained at each point and that they are correctly labeled. The correct working vacuum must be maintained throughout the test.
- d. Check that there is NO FLOW at any other services point (i.e. O<sub>2</sub>, N<sub>2</sub>O, and Medical Compressed Air points).

5. Oxygen Concentrator

- a. All activities of testing and commissioning of the system shall be performed by a qualified engineer of manufacturer in presence of technical team of supplier.
- b. Works shall be executed as per manufacturer's recommendations and as per NF EN ISO 7396-1.
- c. Isolate all other services supply from the distribution pipe work (i.e. Medical C.A, O<sub>2</sub> and N<sub>2</sub>O systems).

J. Controls

Test and prove all automatic equipment, motor starters, changeover valves, indicators and alarms.

3.4 COMMISSIONING

A. General

The Specialist installation Contractor shall, immediately prior to medical use, carry out the following:

1. Carry out the total flow rate and delivery pressure tests in accordance with the recommendations of H.T.M. No. 02-01:2006
2. Re-purge each system with its correct working gas supplied by the Owner.
3. Refill each system with its correct working gas, supplied by the Employer to the designed working pressure.

Upon satisfactory completion of the installation and tests (which shall also include testing of all automatic equipment such as motors, starters, changeover valves and also indicators and alarms etc.) the system proving documents shall be signed by the Engineer, the Owner and the Specialist Installation Contractor indicating that the installation including connections to terminal outlets, theater fittings, have been checked and carried out in accordance with HTM 02-01 and the specification, and is approved.

A copy of the system proving document shall be retained by each of the signatories.

Note: The Contractor shall ascertain whether the installed medical gas systems are to be operational, following handover of the Project.

If it is established that these systems will not be in use for a minimum period of 3 months after handover, then the systems should be evacuated of the working gas and be filled with medical compressed air.

It should be clearly identified that the systems have been left in this transition stage, and that they are not "ready for use".

B. Commissioning Document

1. At the time of the issue of a handing over certificate the Owner PERMISSION TO WORK will be withdrawn and no further work shall be carried out by the Contractor or Specialist Contractor without an additional permit to work.
2. Following documents shall be provided by the manufacturer in a paper hard copy three (03) Nos. and one copy on CD Rom as part of final acceptance:
  - a. Instruction manuals
  - b. Certificate of tests acceptance
  - c. Certificate Pharmacist
  - d. Certificate of compliance of various organization
  - e. CE Certificate of installed equipment
  - f. Working drawings and updated diagrams

Part 4.0-MEASUREMENT AND PAYMENT

A. General

1. Except otherwise specified herein or elsewhere in the Contract Document, no separate measurement and payment will be made for under mentioned works related to relevant item of Schedule of Prices. The cost thereof shall be deemed to have been included in quoted unit rates of respective items of Schedule of Prices.
2. Complete medical gas piping system should be from same manufacturer. Mixing up products of different standards or those of different manufactures shall not be permitted for the same service.
3. Designing of offered equipment and submission of manufacturer's data, specification, diagram and drawings, installation manuals, operation and maintenance manuals etc.
4. Copy of certifications like: ISO 9001: 2003 - EN ISO 13485: 2008 - EC Directive 93/42/EEC from manufacturer of the equipment.
5. Painting and finishes of equipment.
6. Supply of accessories including supports, brackets, access ladder, installation equipment, miscellaneous tools, winches, scaffolding, etc., required for proper erection of equipments as recommended by the manufacturer.
7. Handling and proper storage of equipment prior to installation.
8. Provision of necessary guidance and supervision for civil works to the Civil Contractor, which will be carried out for equipment installation.
9. Provision of any hole cutting in slab / walls or cutting of walls required for proper installation/erection of equipment. Finishing of walls after erection of all such equipment.

10. Rectification of any damage done to civil works for erection or other purposes.
11. Testing and commissioning of equipment after installation including supply of requisite manpower and testing tools/instruments and completion of documentation.
12. Training of Employer's personnel for operation and maintenance of equipment.
13. Maintenance of work during defect liability period including supply of necessary spares/other material and maintenance personnel needed to keep equipments in perfect operating condition.

B. Measurement

No Measurement shall be made for item supplied under this contract.

C. Payment

Payment shall be made at the contract rate entered in the Schedule of Prices for items accepted by the Engineer.

PART 5- RECOMMENDED BRANDS AND MANUFACTURERS

- Beacon Medaes, UK
- Penlon, UK
- Precision Medical, UK
- Rifair Medical Systems, France
- Medgas Technik, Germany
- Üzümcü, Turkey

\*\*\* End of Section 8467 \*\*\*

## **SECTION – 9000**

### **SPECIAL PROVISIONS**

#### **01. SCOPE OF WORK**

The scope of work given in relevant sections of equipment shall include but not necessarily be limited to the following:

- Design, preparation of all relevant installation / erection drawings, obtaining government and / or Employer required approvals and / or certificates, fabrication, installation, testing, commissioning, and maintenance thereafter for the stipulated period of equipment including training of Employer's staff.
- All wiring and controls including necessary material and accessories beyond the power supply point provided at the load break switch near the equipment.
- All other miscellaneous equipment and/or work required to render the equipment ready for continuous, safe and efficient operation.
- Cutting, patching and repairing of damaged civil works required during installation of equipment.
- Inspection of already constructed related civil works immediately after award of work and confirmation of it's suitability for the equipment.
- Maintenance and periodic servicing of equipment during defects liability period (i.e 365 days) including greasing, oiling, cleaning etc. of parts as recommended by the manufacturer.
- Provide all required installation, operation and maintenance manuals, spares lists, drawings and diagrams, inspection test certificates and submission of misc. requisite documentation.
- Providing training to Employer's Staff at site regarding operation and maintenance of the equipment.

#### **02. CODES AND STANDARDS**

Original copies of latest version of all applicable codes & standards are to be supplied by the Contractor. All equipment & materials under this works shall be furnished in conformity with latest edition of applicable standards of ASME, BS, AWS, NFPA, ASTM, NEMA, IEE, etc. and applicable Government and Local Codes governing the same. In case of conflict, the stricture requirements shown/specified shall govern. All equipments shall be rated and tested as per relevant standard (latest edition).

Where possible, the same codes and standards shall be used throughout a particular facility. However, the final decision on with codes and standards shall be applied shall remain with the Engineer.

Abbreviation for codes and standards referred in the contract are as under:

- |         |   |
|---------|---|
| - ASME  | American Society of Mechanical Engineers, USA |
| - BS/EN | British Standards / European Norms            |
| - AWS   | American Welding Society                      |
| - NFPA  | National Fire Protection Association          |

- ASTM                      American Society for Testing and Materials, USA
- NEMA                     National Electrical Manufacturer's Association
- IEE                        Institute of Electrical Engineers, London
- AISC                      American Institute of Steel Construction
- ICC                        International Building Code
- Building Code of Pakistan

### 03. **QUALITY STANDARD**

To guarantee a high quality standard in the field of designing, fabricating, installing and maintaining the said equipment, only manufacturers and installer / supplier with a proven record of following criteria will be considered in the Bid evaluation. To verify the manufacturer's and installer / supplier's experience, a reference list with completed projects should, therefore, accompany the Bidding documents:

#### 3.1 **Manufacturer:**

- i) If the equipment is supplied other than recommended manufacturer (as per section 8467 (recommended manufacturer list) then origin of equipment shall be from USA, UK, Western Europe or Japan.
- ii) The manufacturer of the equipment shall have a minimum of 30 years experience in the design and manufacture of similar types of equipment.
- iii) The name of the manufacturer, part numbers and serial numbers shall appear on all major components.
- iv) Offered units should be in successful operation in at-least 20 hospitals in Pakistan for past five (05) years.
- v) All devices, components and equipment shall be new, standard products of the manufacturer's latest design and suitable to perform the functions intended.

#### 3.2 **Installer / Supplier:**

- i) The supplier should have authorized sole distributor / sole dealership / sole agency holder from the manufacturer of offered equipment in the name of the supplier.
- ii) The supplier should have PEC Registration Certificate in the relevant category and NTN certificate.
- iii) The supplier must have successful experience of supply and installation of offered equipment during last five years as an average of minimum twenty (20) Nos. of hospitals.
- iv) The supplier must have successful experience of maintenance of offered equipment during last five years as an average of min. fifteen (15) Nos. of hospitals.

#### 04. **PRODUCT HANDLING AND STORAGE**

It will be the Contractor's entire responsibility to ensure that all necessary precautions are taken during transportation to avoid damage to any of the equipment.

The Contractor must arrange with the supplier of mechanical equipment, well in advance, that there is sufficient clear and load bearing passage at site to be used for shipping the equipment to the installation place. The Contractor shall also liaise with the equipment supplier with regard to adequate openings and lifting points.

Specific handling or storage requirements will be dealt with in the relevant parts of the specifications, where necessary.

#### 05. **INSPECTION AND CONTROL**

##### 5.1 **General**

The Contractor shall ensure that the manufacturer continuously conducts his own thorough inspections of all equipment during manufacturing and installation.

The Engineer shall have the power at any time to inspect, examine and test any part of the works, or any materials or plant intended to be used in the works, either on the site or at any factory or workshop where such parts, materials or plant are being constructed, manufactured or from which they are being obtained.

##### 5.2 **Pre-shipment Inspection**

Following Equipments are subjected to Pre-Shipment Inspection:

- Medical Oxygen Concentrator
- Air Compressors
- AGSS Plant
- VIE for Liquid Oxygen
- Medical Vacuum Plants

Equipment to be supplied under this Contract shall be subject to inspection and testing by one representative of Employer and one representative of Engineer at its point of original manufacture or final shop assembly before its packing & dispatch to site. The Contractor shall make necessary arrangements and provide all the facilities required for the representatives of Employer and Engineer for conducting such inspection, at Contractor's cost. The cost of travel including overseas travel, arranging of Visas, boarding and lodging of representatives of Employer's and Engineer's shall be the responsibility of the Contractor.

In addition, the Contractor shall provide daily allowance (US\$ 300/man day) for out of pocket expenses to each of Employer's and Engineer's representatives nominated for inspection. The number of days shall be actual days spent in travel calculated from the dates of travel from and to hometown of the concerned representative. The daily allowance in cash (US\$) shall be provided before start of travel from hometown.

The Contractor shall submit tests procedures for approval of Engineer well in advance to the set date of pre-shipment inspection.

The Contractor shall give at-least 3 (three) week notice to the Employer/Engineer for attending such inspections/tests.

### **5.3 Inspection at Site Works**

All equipment/materials supplied by the Contractor shall be inspected by the Engineer after delivery of the same at site to assess any damage or short of quantities and any other requirements of the specifications. The Engineer will issue an inspection certificate if the supplied items of equipment and material are found to be satisfactory.

The Engineer shall inspect the works in progress as and when considered necessary by the Engineer and the Contractor shall provide full access and assistance to the Engineer for carrying out inspection to verify the conformity of works as shown on Drawings and as specified. Such inspection if made shall not relieve the Contractor from any obligations under the Contract.

### **5.4 Damages, During Transportation, Storage & Installation**

The Contractor shall be responsible for any damage of the Equipment/material during transportation to site (if applicable), storage and installation until satisfactory handing over the works to the Employer. The Contractor shall replace any damaged equipment/materials at his own cost.

## **06. DRAWINGS AND SUBMITTALS**

In general, the following submittals are required for the works covered under this section. However, the final decision with regard to what should be submitted, to what extent and at which time of the contract period shall remain entirely with the Engineer.

### **6.1 Technical Data Sheets**

All Bidders are required to submit with their Bid submission the completed Data Sheets along with a comprehensive range of technical literature of the proposed equipment including make, origin of supply, resourcing info for outsourced components, drawings and brochures/catalogues to show that their equipment is of a standard make and complies with the laid down specifications.

All Bidders are required to adopt great care when filling in the characteristic data of their equipment. The data sheets will be used for evaluating the Bid and will subsequently form part of the contract documents. Failing to submit the completed data sheets and the technical literature may result in the rejection of the Bid.

### **6.2 Outline Drawings**

The Contractor must submit with his Bid submission outline drawings showing the arrangement of the equipment and the relevant electrical installations offered by him.

The drawings must be prepared keeping the dimensions shown on the architectural and mechanical drawings in mind.

The Out-line drawings will constitute part of the Bid evaluation.

### **6.3 Design Drawings/Shop Drawings**

The successful Bidder shall submit Design Drawings/Shop Drawings within two (2) weeks from acceptance of Bid to the Engineer for approval.

The drawings must show in reasonable detail installation and design features such as:



- i. Final arrangement of equipment keeping in view the dimensions provided in architectural drawings and civil construction for the Equipment.
- ii. Maximum dynamic and static loads imposed on building structures
- iii. Dimensions and locations of all services, openings in floors and walls, location of embedded parts and location of required electrical connection.
- iv. The Contractor shall review the civil construction drawings related to the equipment and identify any shortcomings/rectifications essentially required for equipment installation prior to construction of civil works.
- v. Wiring and control logic diagrams.
- vi. All other relevant information required by the Engineer.

Approval given by the Engineer is to be understood as an approval to proceed with the works. The approval does not in any way release the Contractor from his contractual obligation to supply, install and maintain the equipment supplied by him as laid down in the specifications.

#### **6.4 As-Installed Drawings**

Such drawings, diagrams and schedules as will, in the opinion of the Engineer, provide an adequate record of the work "as installed" shall be submitted to the Engineer for approval before the issuance of taking over certificate.

The drawings shall include particulars of all items of equipment, including wiring diagrams, etc. As-installed drawings shall be submitted to the Engineer at least 30 days before issue of handing / taking over certificate.

The size of the as-installed drawings shall be of size A1 (minimum). Every item and dimensions in drawings must be legible.

#### **6.5 Installation, Operating and Maintenance Manuals**

One set of reproducible (soft) and three sets of prints of As-Build / As installed drawings along with two sets of installation manual for the equipments shall be supplied by the Contractor prior to commencement of installation of equipment.

At least 30 days prior to the scheduled date of practical completion, the contractor shall supply a complete set of operating and maintenance manuals to the Engineer for approval. Once approved, the Contractor shall proceed to prepare and hand to the Engineer four sets of the approved operating and maintenance manuals.

The manuals shall be neatly bound and provided with a suitably captioned hard cover. The contents shall be generally arranged in the following manner unless otherwise specified/required.

- Index
- General description of the complete facility.
- Fault detection and removal instruction during operation.
- Emergency directions of the complete facility.
- Safety control adjustment and settings of all safety protection equipment.

- List of equipment giving manufacturers' and agents' name, and name plate data together with all data sheets published by the equipment manufacturer.
- Dismantling, installation, operating and maintenance instructions for each item of equipment (including lubricating charts).
- List of spare parts for each item of equipment as recommended by the manufacturer.
- List of essential tools recommended by the manufacturer for operation and maintenance.
- As-installed drawings.

All above submission shall be signed and stamped by the Contractor prior to submission and all submission shall be in English. The approval by the Engineer of the above submission shall not be held to relieve the Contractor of any part of his responsibility to meet all of the requirements of this Contract.

## **07. OPERATION AND MAINTENANCE**

### **7.1 Maintenance During Defects Liability Period**

The Contractor shall include the maintenance and guarantees of the whole of the Contract Works as laid down in the General and Special Conditions. During this term, the Contractor shall remedy and/or replace all defective parts or items and correct any omissions certified by the Engineer.

The Contractor will also be held liable for any costs of dismantling or re-erection which may have to be undertaken in order to replace defective parts.

Continuous service shall be provided on a routine weekly basis.

Emergency service shall be available on short notice.

Service shall be performed by skilled personnel under the supervision of an experienced supervisor.

The maintenance shall include and the Contractor will be held liable for any costs of inspection of all equipment, lubrication of all bearings, supply of all consumables, supply of necessary oil & grease, supply of cotton waste, running adjustments and keeping the installation and equipment in a clean condition unless otherwise specified/required by the Engineer.

### **7.2 Register Of Service And Maintenance**

The Contractor shall provide a register of service and maintenance for the installation. Where such requirements are specially required by any regulation of authorities having relevant jurisdiction over this contract work this shall be complied with strictly.

The Contractor shall also provide and maintain a record of all services, maintenance and repair work carried out in detail. Such record shall be prepared in duplicate and should be in the form of a maintenance/repair sheet with one copy to be retained by the Engineer upon the execution of such services.

All registers and records shall be kept by competent persons in the employment of the Contractor during the period for which he is responsible for maintaining the installation.

## 08. **TOOLS & INSTRUMENTS FOR SERVICING AND MAINTENANCE**

The Contractor shall supply and deliver to site a complete set of essential tools and other instruments necessary for proper servicing and maintenance of the equipments. Tools shall not include special tools and instruments, which are necessary for overhauling and commissioning of the equipment. The tools shall be supplied in the form of complete kits and shall be contained in well constructed and compartmented tool boxes. The Contractor will not use these tools during installation, testing, commissioning and defect liability period.

### 8.1 **SPARE PARTS**

#### i) Consumables

The Bidder shall provide with the Bid recommended list of consumable spares (with part number) for a minimum period of two (2) years of operational duties or otherwise as mentioned in the relevant equipment specifications. All items to be separately listed.

#### ii) Normal Spare Parts

The Bidder shall provide with the Bid a recommended list of spares and components (other than the above consumables), which shall be required to maintain each equipment over a period of two (2) years of operational duties or otherwise as mentioned in the relevant equipment specifications. Each item to be separately listed.

## 09. **PAINTING & FINISHES**

All equipment, machinery, gears, controls, exposed and unexposed steel work shall be thoroughly cleaned, freed from oil, grease and other foreign substances detrimental to good finishing.

Apply approved primer, undercoats and finishing coats on a properly prepared surface in accordance with the paint manufacturer's recommendation and in accordance with recognized international standards.

The type and shade of paints, particularly of the finishing coat shall be subject to the Employer's/Engineer's approval.

Enamel (where required) shall also be applied according to the manufacturer's recommendation. Stainless steel finish shall be No.4 finish or equivalent, unless specified otherwise in the specification. If field touch-ups of abraded and damaged surfaces become necessary, the same type of paint used in the factory shall be employed.

## 10. **TESTING AND COMMISSIONING**

On the completion of the Work substantially in accordance with the Contract, the Contractor shall give the Engineer notice in writing thereof and before making the "Testing and Commissioning" shall give the Engineer and the local authority seven days notice in writing of the date on which he will make the said tests of the work in accordance with relevant codes and in the manner prescribed by the Specification.

Unless otherwise agreed, the Contractor shall commence such tests upon the date and shall carry out the same, in the presence of the Engineer or his authorized representative, whose name shall previously have been communicated in writing to the Contractor and the local authority.

If any portion of the works fails under the tests to fulfill the Contract conditions, the Contractor shall inform the Engineer thereof in writing, and tests of the faulty portions

shall, if required by the Engineer be repeated within a reasonable time upon the same terms and conditions.

If the "Testing and Commissioning" is not successfully made by the Contractor within one week after the date fixed by the Contractor for the completion for operational use or for the testing of the works, the Engineer may in writing call upon the Contractor under seven days notice to make such tests, and on the expiry of such notice such tests shall forthwith be made by some other agency appointed by the Engineer at the expense of Contractor.

The Contractor shall supply all necessary utilities, labour, apparatus and instruments necessary for the prescribed tests. The accuracy of the Contractor's instruments shall be demonstrated if required.

The Contractor shall make for payment of all or any fees charged by the local authorities for the above.

Each section of the installation will be required to operate within the specified limits of its rating either continuously or intermittently as may be required without failure of any kind for a period of one year after the "Testing and Commissioning" of each section, the date of completion of the above being certified by the Engineer.

The installation will be under the charge of the Contractor during this period, at which time the Contractor shall instruct the Employer's personnel on the maintenance, servicing and trouble shooting of the various plants and system.

#### **11. TEST CERTIFICATES AND REPORTS**

The Contractor shall provide copies of all test certificates/reports including the following:

- (i) Test Certificates of critical materials
- (ii) Factory test reports
- (iii) Pre-shipment test report
- (iv) Report of testing & commissioning of equipment

#### **12. TRAINING**

On completion of all works, but prior to final taking over, the Contractor shall arrange for free training and instruction to be provided to the client's maintenance staff and operators. This training shall cover all aspects of the operation and maintenance of the plant/equipment and shall ensure that the trainee is provided with at least the necessary fundamentals required for the safe and efficient operation of the plant/equipment in question. The instructor(s) must be competent and experienced personnel, well acquainted with the task of lecturing.

The schedule of offered training highlighting the details of syllabus indicating number of hours for training and field instruction subject to be taught and no. of Clients staff strength to be trained shall be enclosed with each Bid so as to allow for an evaluation by the Engineer.

#### **13. GUARANTEE**

The Contractor shall submit two copies of written guarantee that the material and workmanship of the equipment installed is according to recognized international standards and conform to all contractual requirements of this specification that he will make good without extra cost any defects not due to ordinary wear and tear or improper use, which may develop within one year from date of the installation being handed over to the Employer.

During the last month of the guarantee period, the Contractor shall demonstrate to the Engineer that all equipment and accessories are operating to the required specifications.

The guarantee period shall be one year after final commissioning.

In case if equipment remains out of order for more than 10 days or more, guarantee/maintenance period will be extended accordingly.

14. **MEASUREMENT AND PAYMENT**

No measurement and payment shall be made for the works involved within the scope of this section of specifications unless otherwise specifically stated in the schedule of prices or herein. The cost thereof shall be deemed to have been included in the quoted unit rate price of other items of the schedule of prices.

\*\*\* End of Section 9000 \*\*\*