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ABDULWAHED CHEHAB
CONSULTING ENGINEERING OFFICE

PART 1

CIVIL, STRUCTURAL AND ARCHITECTURAL

SPECIFICATIONS

VOLUME 2
SPECIFICATIONS

PART 1
CIVIL, STRUCTURAL AND ARCHITECTURAL

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CHAPTER ONE
SITE PREPARATION & DEMOLITION

1.0 GENERAL

1.0.1 SCOPE OF WORK

The work comprises of School Extension and Rehabilitation Works (170 public Schools).

1.0.2 SITE PROTECTION

The contractor should take all measures to protect the site and to protect the users during the rehabilitation period as per the Engineer instructions.

1.0.3 The contractor should not allow or add any load to the existing body to avoid any risk in construction works.

1.0.4 At the beginning of the works, the contractor should clean the site and the surrounding from all obstacles and remove all debris to outside the site.

1.0.5 After the completion of works, the contractor should clean the site and works location and make good all places related to his works.

1.1 DEMOLITION & REMOVAL OF DEBRIS

1.1.1 SUMMARY

A. This Section includes the following:

1. Demolition and removal of structures.
2. Demolition and removal of site improvements adjacent to a building or structure to be demolished.
4. Disconnecting, capping or sealing, and abandoning in place or removing site utilities.

1.1.2 DEFINITIONS

A. Remove and Salvage: Carefully dismantle and/or detach from existing construction. Store, protect, and transport and deliver to Employer.

1.1.3 SUBMITTALS

A. Proposed Dust-Control and Noise-Control Measures: Submit statement or drawing that indicates the measures proposed for use, proposed locations, and proposed time frame for their operation. Identify options if proposed measures are later determined to be inadequate.

B. Schedule of Building Demolition Activities: Indicate the following:

1. Detailed sequence of demolition and removal work, with starting and ending dates for each activity.
2. Interruption of utility services.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Locations of temporary protection and means of entry and exit for Contractor, and occupants affected by building demolition operations.
5. Coordination of continuing occupancy of adjacent buildings and partial use of premises.

C. Predemolition Photographs: Take photographs to show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by building demolition operations. Submit before Work begins.

D. Inventory: After building demolition is complete, submit lists of components and items that have been removed and salvaged or removed for re-use.

E. Predemolition Meeting: Conduct meeting at Project site to review methods and procedures related to building demolition including, but not limited to, the following:

1. Inspect and discuss condition of construction to be demolished.
2. Review structural load limitations of existing structures.
3. Review and finalize building demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review and finalize protection requirements.

CHAPTER TWO
EXTERNAL WORKS

2.1 EXCAVATION, BACKFILLING AND EARTHWORK

SUMMARY

A. This section includes the following:
   1. Excavating and backfilling for structures, roads and walkways.
   2. Granular base course for support of building slabs is included as part of this work.
   3. Preparation of subgrade for structures.
   4. Preparation of subgrade for roads.

DEFINITIONS

A. Excavation consists of removal of material encountered to subgrade elevations indicated and subsequent disposal of materials removed.

D. Subgrade: The undisturbed earth or the compacted soil layer immediately below granular base, concrete blinding layer, base course or topsoil materials.

PROJECT CONDITIONS

A. Use of Explosives: Use of explosives is not permitted.

B. Protection of Persons and Property.
   1. Barricade open excavations occurring as part of this work and post with warning lights.
   3. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
   4. Perform excavation by hand.

STORAGE OF EXCAVATED MATERIALS

A. Stockpile all satisfactory excavated materials which are to be re-used for backfill and fill, where directed. Place, grade, and shape stockpiles for proper drainage, and locate away from edge of excavations.

BACKFILL AND FILL

A. General: Place soil material in layers to required subgrade elevations.
   1. Under walkways: use satisfactory excavated or imported material, approved by the Engineer.
   2. Under roads: Use satisfactory excavated or imported material having a soaked CBR of not less than 20%.

B. Backfill excavations as promptly as work permits, but not until completion of the following:
   1. Acceptance of construction below finish grade including, where applicable, damp proofing, waterproofing and perimeter protection.
   2. Removal of trash and debris from excavation.
   3. Permanent or temporary horizontal bracing is in place on horizontally supported wall.

PLACEMENT AND COMPACTION

A. Placement and compaction methods and equipment shall be approved by the Engineer. Heavy steel and pneumatic rollers are not allowed to be used inside building areas.

B. Control soil and fill compaction, providing minimum percentage of density specified for each area classification indicated below. Correct improperly compacted areas or lifts as directed by Engineer if soil density tests indicate inadequate compaction.

Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density, in accordance with ASTM D 1557 :

1. Under structures, compact top 300 mm of subgrade and each layer of backfill or fill material at 95 percent maximum density.
2. Under lawn or unpaved areas, compact top 150 mm of subgrade and each layer of satisfactory soil material at 90 percent maximum density.
3. Under walkways, compact top 150 mm of subgrade and each layer of satisfactory soil material at 95 percent maximum density.

C. Under roads: finished subgrade immediately prior to placing subsequent material shall be compacted to not less than 95% maximum dry density to 150 mm depth (modified AASHTO) as determined in the laboratory.

D. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction or re-compaction, uniformly apply water in minimum quantity as necessary to prevent free water from appearing on surface during or subsequent to compaction operations.

1. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
2. Stockpile or spread soil material that has been removed because is too wet to permit compaction. Assist drying by discoing, harrowing, or pulverizing until moisture content is reduced to a satisfactory value.

GRADING

A. General: Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated or between such points and existing grades.

B. Grading Surface of Fill under Building Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 13mm when tested with a 3.0 m straightedge.

BUILDING SLAB BASE COURSE

A. General: Base course consists of placement of granular base material, in layers of indicated thickness, over subgrade to support concrete building slabs.

B. Placing: Place granular base material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Compact to 95% maximum density in accordance with ASTM D 1557.

1. When a compacted granular base course is indicated to be 150mm thick or less, place material in a single layer. When indicated to be more than 150mm thick, place material in equal layers, except no single layer more than 150mm or less than 75mm in thickness when compacted.

DISPOSAL

A. Unsatisfactory excavated material, trash, debris and other waste materials:

1. Remove from the site and dispose of legally, at Contractor's expense.

B. Satisfactory excavated material excess, surplus to backfill and fill requirements:

1. Remove from the site and dispose of legally, at Contractor's expense.

2.2 ROAD BASE COURSE

PART 1 - GENERAL

SUMMARY

A. The extent of the work is shown on the drawings and includes providing, spreading and compacting granular road base in compliance with the specifications and in conformity with grade, lines and thickness shown on the drawings.

PART 2 - PRODUCTS

GRANULAR ROAD BASE

A. General: Sound, naturally occurring material, or angular crushed stone, clean and free from organic matter and

unsuitable material or other deleterious substances and be in such condition that it can be readily compacted under watering and rolling to form a firm and stable base.

PART 3 - EXECUTION

SUBGRADE PREPARATION

A. Check subgrade for conformity with elevations and section immediately before placing granular base. Materials are only to be placed on subgrades approved by the Engineer.

PLACING OF GRANULAR BASE

A. Deliver granular base material as a uniform mixture and place on the road bed by means of method approved by the Engineer controlled mechanical spreader, and at a uniform quantity per linear metre and at rate which will provide the required compacted thickness specified. Avoid segregation of material and material not uniform in mixture. Place material in compacted layers at optimum moisture content of approximately equal thickness. Unless otherwise approved thickness is not to exceed 150 mm for any one layer. When placed in 2 or more layers, permit first layer to dry just sufficient for stability during placing of the subsequent layer. Permit the completed base to dry just sufficiently for stability during placing of any covering materials.

COMPACTING AND GRADE TOLERANCE

A. Carry out plate bearing tests in accordance with ASTM D 1196 . At least one (1) Plate bearing test shall be carried out at selected locations for every 200 m2 of granular base. The bearing value of the granular base is not to be less than 1200 Kp using 300 mm diameter plate for 5 m deflection and 10 repetitions.

B. The surface of the finished base shall not vary by more than 10 mm when tested with a 3m straightedge when placed on, and parallel or perpendicular to the centre line of the roadway and the compacted base shall not vary by more than +5/-10 mm from the required elevation. Correct all depressions and humps exceeding the specified tolerances.

2.3 PRECAST CONCRETE PAVEMENTS AND CURBS

PART 1 - GENERAL

SUMMARY

A. The extent of precast concrete pavements and curbs is indicated on drawings. Types include:
   1. Tile: walkway and area pavements.
   2. Curb: at roadways and car parks.

B. The Contractor shall engineer and design all precast concrete pavement and curb assemblies, including, sub base, tooling, control joints and locations, and all other details and junctures with other materials and systems, to provide pavements and curb installations.

QUALITY ASSURANCE

A. Codes and Standards: conform and comply with ASTM or BS or alternative equivalent standards acceptable to the Engineer which establish minimum qualitative and quantitative standards for the materials, production and installation of precast concrete paves tiles and rood curbs.

B. If units are not produced at precast concrete fabricating plant, maintain quality control procedures and conditions acceptable to Engineer.

DELIVERY, STORAGE AND HANDLING

A. Deliver precast concrete units to the site in such quantities and at such times to ensure continuity of installation. Store units at site in such manner as to prevent cracking, chipping, distortion, staining or other physical damage.

PART 2 - PRODUCTS

MATERIALS

A. Precast Concrete Materials: Comply with the relevant requirements specified for cast in place concrete materials.

B. Mortar Bedding and Grout Materials: comply with the relevant requirement specified for unit masonry mortar

and grout materials.

C. Joint Filler: Premoulded bituminous fibreboard.

MIXES

A. Tiles and Curbs: Prepare design mixes for each type of precast concrete unit to achieve minimum Class B cast in place concrete characteristics. (Refer to Chapter 3).

B. Base and Backing: cast in place concrete, Class C. (Refer to Chapter 3).

C. Mortar Bedding and Grout: Cement and sand proportioned by volume in parts 1:3.

FABRICATION

A. General: Tiles and curbs may either be obtained from an approved manufacturer or otherwise manufactured on site by the Contractor.

B. Production cast and cure precast units by approved methods conforming to referenced standards and a manufacturing system which includes:
   1. Mechanically vibrated molds.
   2. Hydraulically applied pressure.
   3. Curing by totally immersing in water for at least 24 hours after initial set has taken place, or other approved method.

PRECAST CONCRETE PRODUCTS

A. Tile Pavers: Plain face with square edges:
   1. Surface: Smooth, non-slip.
   2. Dimensions: As indicated:
      a. 600mm x 600mm x 40mm thick, or
      b. 250mm x 250mm x 25mm thick
   3. Color : Grey or as required by the Engineer.

B. Curbs: plain with square edges and ends.
   1. Dimensions: approved uniform lengths to profiles as indicated on drawings or otherwise required.
   2. Color: Grey.

PART 3 - EXECUTION

PREPARATION AND INSTALLATION

A. Subgrades: Prepare and compact subgrade formations to 90% maximum density or 70% relative density.

B. Curbs:
   1. Base and Backing: Place compact and cure cast in place concrete curb. Foundation as indicated or required. Place and compact 150mm wide curb backing, up to the under side of adjacent pavements.
   2. Bedding and Jointing: set curb and grout up joints in cement mortar. Point joints smooth and flush with curb.

C. Tile Pavements:
   1. Base: Place, compact and cure cast in place concrete sub base; 100mm thick bed unless otherwise indicated or required.
   2. Bedding and Jointing: Set pavers and grout joints in cement mortar. Points and tool joints grooved, to a uniform depth of 3mm.

D. Control Joints: Install joint filler as indicated or required at pavement and curb control joint locations.

REPAIR, CLEANING AND PROTECTION

A. Remove and replace unit pavers and curbs which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units and install in same manner as original units, with same joint treatment to eliminate evidence of replacement.

B. Cleaning: Remove excess mortar/grout from exposed surface, wash and scrub clean.

C. Protect pavements and curbs from damage and wear and maintain conditions in a manner acceptable to the engineer.

2.4 EXISTING WALKWAYS

2.4.1 SCOPE

Repair existing walkways at project site boundary; precast concrete paver tiles, bases courses, etc., as necessary, where damaged or disturbed by new construction; make good and joint at junction with new precast concrete paving and/or curbing as required and to Engineer's approval.

To be read in conjunction with Chapter 2 and Chapter 9.

2.5 PLANTING

2.5.1 SCOPE

A. These Works shall consist of the furnishing of all materials and the construction, installation and completion in all respects of landscape planting.

B. Landscape planting refers to items associated with preparing areas of planting and the planting of trees, shrubs, ground cover, vines, grass, and turfing.

2.5.2 LANDSCAPE PLANTING STANDARDS

A. The Contractor shall be responsible for the quality of all items purchased and shall submit and inspection plans for review. The inspection plan shall cover those items intended for shop inspection and the procedures for carrying out such inspections.

2.5.3 PRODUCTS AND MATERIALS

A. Agricultural Soil

A.1 Soil shall be obtained from well-drained arable land approved by the Engineer before its use. It shall be free draining, non-toxic and capable of sustaining healthy plant growth. Soil shall not contain subsoil, refuse, roots, heavy clay, noxious weed, phytotoxic materials, coarse sand, rocks, sticks, brush, litter or other deleterious materials.

A.2 Agricultural soil brought on to the Site without prior inspection and approval shall be at the risk of the Contractor, who shall remove it at his own expense unless otherwise instructed by the Engineer.

B. Fertilizers

B.1 Inorganic fertilizers shall be applied to the irrigation water by the use of injection equipment. Fertilizers shall be approved soluble NPK fertilizers in a suitable ratio applied at a dilution rate of one kg fertilizer to 1,000 ltr of water.

B.2 Proposals for use of any of the following alternative fertilizer types and composition where injection equipment is not specified for use, may be submitted for consideration: However, the suitable fertilizer type and grade shall be determined, after testing the soil samples, to suit that type of plantation desired.

C. Plants Generally

C.1 All plants shall comply with BS 3936, Part 1, and be of the size specified. No plant shall be less than the minimum size and at least 50% shall be in the upper part of the specified range. Plants that meet the measurements specified but do not possess the normal balance between height and spread will not be accepted.

C.2 All planting stock shall be well-balanced and well formed, sound vigorous, healthy and free from disease, sunscald, abrasion, harmful insects or insect eggs and with a healthy unbroken root system. Unless otherwise specified, only nursery-grown plants shall be used.

C.4 All plants supplied shall have been grown form the Contractor's own nursery stock or obtained from a reputable nursery, and shall be subject to approval by the Engineer at the source prior to digging for transport to the project site.

C.5 If specified plants are unobtainable, details of alternatives shall be submitted with the Tender, stating how they differ form the plants specified. Such substitutions shall be subject to approval.

H. Trees (Other Than Palms)

D.1 Trees shall be symmetrically developed, their structure and habit of growth typical of their species or variety with straight stems and an intact central leader. All trees shall be root pruned at the source prior to shipment to the project site and are to be supplied earthballed and Hessian covered or container grown. Bare root trees shall not be acceptable without prior approval of the Engineer. Trees shall have a minimum height of 1.8 m above planting level.

D.2 Where trees of 1.8 m height are unobtainable, and subject to the submission of evidence to that effect, the Contractor may, if approved, substitute trees of 1.5 heights.

D.3 Anti-desiccant shall be applied to all trees no more than 24 hours prior to shipment from the source to the project site. The Anti-desiccant sample shall be submitted to the Engineer for approval in unopened containers of the manufacturer prior to application.

E. Palms

E.1 Palms shall be balled and burlapped unless container grown palms are available. Offshoots will not be accepted. They shall have a vigorous root system, a crown of new leaves, proper color of leaves of an adult palm and sufficient hardiness. Fronds shall exhibit no signs of moisture stress. All palms shall have straight 10 runks. Any tree having a weak or thin trunk not capable of supporting itself when planted in the open will not be accepted. They shall be of a quality equal to heavy trunk type palms designated as "Florida Fancy" in the Florida Department of Agriculture and Consumer Service Publication.

E.2 Height of palms shall not be less than 1.5 from planting level to the base of the growing tip.
Palms of 1.5 m height shall have a root-ball diameter of 0.75m to 0.9m;
Palms of 2m heights shall have a root ball diameter of .90m to 1.10m
Palms of 2.4m heights shall have a root ball diameter of 1.10m to 1.30m.
Palms of 3.0m heights shall have a root ball diameter of 1.30m to 1.50m.

E.3 Palms trees shall be root pruned one year before removal from the original growing site. The pruning trench shall be backfilled with wet peat or equal and the tree sprayed with anti-desiccant.

E.4 Palms shall be dug and prepared for shipment in a manner that will not cause any damage to the fronds, bud, shape, root system and future development of the plants after replanting.

E.5 Care shall be taken that the root ball is planted intact and the terminal bud is undamaged. Damaged palms shall be replaced at the Contractor's expense.

E.6 Guying of the palm trees shall be specified by the Engineer.

E.7 Palms shall be irrigated and basins shall be prepared to retain the water. The Contractor shall provide sub-soil drainage to the palm growing area in case the palm pits do not drain properly.

E.8 The Contractor will be required to replace, at his own expense, planting material that does not grow and fails to survive while in the site nursery or holding area. All plants that show signs of failure to grow at any time, as determined by the Engineer, shall be removed ad replaced. The Engineer will inspect the nursery growing grounds once a week a\or at longer intervals, at his discretion and will mark or indicate the plants to be replaced. Any plant requiring replacement should be replaced with a plant of equal size and age as the plant found unsuitable should have been at the date of replacement, removal, transporting and installing of the plants shall be performed by the Contractor at his own expense.

E.9 If the palms have been temporary heeled-in or held in a project nursery for more than 45 days. The following procedures shall be followed immediately prior to relocation for final planting:

- Trim off matured fronds using a very sharp knife.
- Trim semi-mature fronds by leave a total of 10 to 14 fronds, either mature of semi-mature, to protect the growth bud.
- Trim off all suckers and fruiting stalks.
- The remaining frond shall be tied upright with twine to surround the growth bud. The fronds shall be then trimmed to about 2/3 of their original length. These tied fronds shall then be neatly wrapped with burlap and tied again to hold the burlap in place.
- After wrapping fronds, the soil around the palm tree will be irrigated to field capacity. The palm will not be dug until the soil is in a friable condition. If the palms must remain in the ground in a wrapped condition for more than two days repeat this irrigation procedure daily.
- Excavate a trench approximately one meter from the trunk to a depth of 1.25 meters. Break the root ball loose from the ground by prying. (Use of a backhoe to excavate around the palm is permissible. It can also be used to remove the palm). The Contractor shall be especially careful not to bump the palm near the growth bud.
- Use a front loader, backhoe or crane and a heavy duty nylon or canvas sling to lift the palm vertically from the pit, with the palms suspended in the vertical position, using sharp machetes, shovels and shears, remove all the dirt and trim the roots to 0.50 meter from the trunk.

F. Tree Stakes and Ties (Excluding Palm Stakes)

F.1 All stakes shall be of timber, straight, free of projections and pointed at one end. The lower ends shall be coated with a non-injurious wood preservative to a minimum height of 0.15m above ground level, to be applied at least 2 weeks before use. Stakes shall be 50mm thick, the minimum length below ground to be 1.3m and the length above to be for the full height of the stem or half full height for feathered species.

F.2 Alternatively, tree stakes shall be mild steel tubes protected by a PVC coating in mid-green or similar approved color. The tops and bottoms of the steel tubes shall be sealed with plastic caps. The external covering shall have horizontal ridges at regular intervals to facilitate the fixing of tree ties. Steel tube shall have a diameter of 35 mm and a height as the timber stakes.

F.3 Wooden and steel stakes shall not be used on the same site.

F.4 Trees ties shall consist of a synthetic rubber compound hose, approved plastic, adjustable strap type or neoprene type approximately .03m in diameter and 0.3 in length, with rubber or Hessian buffer.

G. Guy Wires for Palms

Palms shall be stabilized with four 7-strand galvanized guy wires of 6mm diameter and of a length suited to each tree, fixed to approximately two thirds of the tree height. The wire guy shall be looped around the

palm stem and protected by an approved tree tie.

H. Turnbuckles and Ground Anchors

Each guy wire shall be connected via a 50mm galvanized turnbuckle to a 150mm malleable iron ground anchor fixed by 1.2m long drive rods.

I. Trunk Wrapping Material

Trunk wrapping material shall be Hessian bands75 mm wide and of lengths as necessary for wrapping tree trunks and main branches. Alternatively, purpose made, double thickness heavy kraft crepe paper in rolls not less than 100mm wide with a stretch factor of 33% may be used.

J. Burlap

Burlap shall be jute of 0.20kg/m2 or cloth having same strength and resistance to tearing and capable of rotting in the ground.

K. Twine For Tying

Twine for tying shall be lightly tarred medium or coarse sisal yarn.

L. Plant Labels

Plant labels shall be durable, weatherproof and to state legibly the correct plant and size.

M. Chafing Guards

Chafing guards shall be two-ply reinforced rubber or plastic garden hose of uniform color throughout the work.

N. Cast Iron Tree Grating Frame and Cover

The frame and cover should be of heavy-duty quality and galvanized.

The pattern, the overall size and opening as specified on drawings.

The finish color to be black once painted with 3 coast of epoxy paint.

Sample must be submitted to obtain approval before placing order with supplier.

O. WROUGHT IRON TREE GUARD

The over all sizes as specified on drawing.

The galvanized finish to have 3 coats of black paint.

2.5.4 MEASUREMENT

A. Trees, Palms, Shrubs, ground Cover, Succulents and Climbing Plants shall be measured by the number

of each type furnished, installed, including preparation of planting areas and all necessary agricultural soil, planting medium, fertilizers, staking, tying and incidentals, and accepted.

B. Additional fertilizers, recommended by the Independent Soil Analyst and approved for use shall be measured by kilogram furnished, incorporated in the Works, and accepted.

PAY ITEMS	UNIT OF MEASUREMENT
(1) Trees	Number
(2) Palms	"
(3) Shrubs	"
(4) Ground Cover	"
(5) Succulents	"
(6) Climbing Plants	"
(7) Additional Fertilizers (each authorized type)	Kilogram (kg)

2.6 BOUNDARY WALLS, FENCES AND STEEL GATES

Boundary Walls and Fences

Construct boundary walls and fences complete; fully in accordance with the requirements and provisions of the Specification and as shown and detailed on the Drawings. Including for but not necessarily limited to additional excavation and earthworks below baseline levels, reinforced concrete foundations and substructures, above ground construction and assemblies, including formed and applied finishes, and complete in every respect. Refer to details on drawings to be read in conjunction with Chapter 2, 3 and 9 of the specifications.

Shop drawing required for Engineer's Approval.

Steel Gates

Steel entrance gate assemblies and components as specified and detailed, fabricated and installed complete; INCLUDING for additional excavation, concrete footings, supports, anchorages and fixings; hardware, accessories, trim, finish painting; and all other related ancillaries as indicated or required on drawings. To be read in conjunction with Chapter 5.

Shop drawing required for Engineer's Approval.

2.7 RECYCLING AREA

RECYCLING ROOM

Construct recycling room adjacent to the school fence of 20 cm hollow concrete block walls 200 cm high. The room shall be 360 cm long by 220 cm wide and partitioned by 20 cm by 150 cm high hollow block walls. A new opening shall be made on the fence to allow the transfer of materials from the school to the appropriate vehicles. The room shall be rooted by brick tiling.

Price to include:
Hollow concrete walls, concrete, steel reinforcements, steel structure for roof, brick tiling, mortar, plaster, labor

equipment, windows, doors, and all requirements as per drawings and engineers approval.

RECYCLING CONTAINERS

Provide at least four PVC containers with wheels and cover, each to hold separate recyclable material: metal, glass, paper and plastic.

2.8 TRAFFIC SIGNS AND SIGNALS

Part 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Traffic signs as shown on the drawings or inferable there from and/or as specified in accordance with requirements of the Contract Documents, work includes but not limited to the following:

1. **Ceiling hung signs including illuminated signs**
2. **Wall mounted signs including illuminated signs**
3. **Post mounted signs including illuminated signs.**
4. **Fabrication of sign and sign post.**
5. **Graphic/Lettering.**
6. **Foundation.**
7. **Installations.**

1.02 REFERENCES

A. British Standards Institute (BSI):

1. **BS 381 : "Specification for Colours for Identification Coding and Special purposes"**
2. **BS 873 : "Road Traffic Signs and Internally Illuminated Bollards"**

B. American Society for Testing and Materials (ASTM):

1. **ASTM A 53 : "Specification for Pipe, Steel, Black and Hot Dipped Zinc Coated Welded and Seamless.**
2. **ASTM A 366 : "Specification for Steel, Carbon, Cold Rolled Sheet, Commercial Quality"**
3. **ASTM A 512 : "Specification for Cold Drawn Buttweld Carbon Steel Mechanical Tubing"**
4. **ASTM A 568 "Specification for General Requirements for Steel Carbon and High Strength Low-Alloy Hot Rolled Sheet and Cold Rolled Sheet"**
5. **ASTM D 790 : "Test Methods for Flexible Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials"**
6. **ASTM D 1003: "Test Method for Haze and Luminous Transmittance of Transparent Plastics"**

C. Comply with the relevant schedules and requirements with local regulations.

D. Unless otherwise stated, the design, materials, construction and erection of signs shall comply with the standards in the General Specification for Hospital signage.

1.03 SYSTEM DESCRIPTION

A. Design Requirements:
   1. **Unless otherwise stated, all road signs shall be of the types used for 85% ile speed of under 45 km/hr. category in the Traffic Signs Manual by Local Municipality.**
   2. **Sign plates or boards employing any method of construction, irrespective of their size and shape, shall be capable of passing the rigidity tests stated in the relevant standards.**

1.04 SUBMITTALS

A. Manufacturers Data: Submit to the Engineer, in accordance with the requirements of the Contract Documents, copies of manufacturer's specifications and installation instructions and other data as may be required to show compliance with these Specifications.

B. Shop Drawings: Submit shop drawings for the fabrication and erection of traffic sign work outdoor sign board and indoor sign board. Include details of sections and connections at not less than 1:4 scale. Show anchorage and accessory items and finishes.

C. Samples: Submit to the Engineer, in accordance with the requirements of the Contract Documents, samples as follows:
   1. **150 x 150mm Samples of each metal and finish required.**
   2. **300 x 300mm Samples of each type of acrylic sheet.**

1.05 QUALITY ASSURANCE

A. Provide traffic sign work (outdoor and indoor) fabricated by a firm specializing in the fabrication of traffic and similar signs and who are capable of producing work of the highest standard of quality in the industry.

B. Locate all signs as required. However, the final arrangement and number of signs shall be subject to the approval of the Owner and the Engineer.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver all components to project site completely identified. Store in accordance with manufacturer's instructions, protected from the weather, construction activities and other possibility of damage or loss.

Part 2 - PRODUCTS

2.01 METALS

A. Materials and Surfaces: For the fabrication of metal work which will be exposed to view, use only materials which are smooth and free of surface blemishes. Do not use materials which have stains and discolorations including welds which do not match the materials.

B. Flatness and Edges: For exposed work provide materials which have been cold-rolled, cold finished, cold-drawn, extruded, stretcher levelled, machine cut and otherwise produced to the highest commercial standard for flatness with edges and corners sharp and true to angle or curvature as required.

C. Welding Electrodes and Filler Metal: Provide the alloy and type required for strength, workability, compatibility and color match after grinding smooth and finishing the fabricated product.

D. Ferrous Metal (Steel): Provide the forms and types shown and specified complying with the following or other equal and approved standards and finish.
   1. **Cold-Rolled Sheet Steel: ASTM A 366 and ASTM A 568, commercial quality with type E matt finish.**
   2. **Steel Pipe: ASTM A53, standard weight (Schedule 40), galvanized, type as required to meet the assigned performance.**

3. **Steel Tubing: ASTM A512, sunk drawn, butt welded, cold-finished and stress relieved.**
4. **Base Plates, Anchor Bolts, etc.: Non-corrosive, zinc coated of the type and sizes approved and required to withstand the imposed load.**

E. Fasteners: Manufactured from the following and as approved by the Engineer:
1. **Brackets: Strip aluminum alloy.**
2. **Clips: Aluminum extruded sections.**
3. **Screws, bolts, nuts and washers shall be of steel, stainless steel, aluminum alloy or of a high tensile non-corroding metal. Steel screws, bolts, nuts and washers which are in contact with aluminium shall be coated with zinc or cadmium.**

F. Sign Plate and Stiffening Frame:
1. **Sign Plate**
   a. Steel Construction: Sheet steel not less than 1.25mm thick.
   b. Aluminum Construction: Aluminum sheet not less than 3mm thick.
2. **Stiffening Frame: Manufactured from approved aluminum sections. Provide stiffening frames for plate signs having the following dimensions:**
   a. Circular signs size over 600mm diameter.
   b. Triangular signs with base width over 600mm.
   c. All other signs where:
      i) The horizontal or vertical dimension of the sign exceeds 1000mm.
      ii) The maximum dimension is greater than 600mm and the ratio W/D or D/W is equal to or greater than 2.5; where D is the depth and W is the width of the sign.

G. Mounting Posts for Plate Signs
1. **Circular hollow section steel of approved size.**
2. **Post Caps: Cast or sheet metal, or a suitable weather resistant type of plastic, as approved.**

H. Height Limit Gauge Frame: Fabricated from continuous circular hollow section steel complying with B.S. 873 or other approved standards; size 75mm diameter for frame spanning up to 5.00m and size 100mm diameter for frames spanning over 5.00m.

I. All steel used for the complete work shall be of hot dipped galvanized and all aluminum shall be of anodized finish, as approved.

Part 3 - EXECUTION

3.01 INSTALLATION

A. General: Locate sign units. Use mounting methods in compliance with manufacturer's instructions. Install sign units level, plumb and at heights indicated or required, with sign surface free from distortion or other defects or appearance.

B. Metal Signs: Attach metal signs to vertical surfaces of walls, poles, etc., using bolting system, clamping system or other fastening devices recommended by the manufacturer and approved by the Engineer.

C. Acrylic Plastic Signs: Mount the acrylic plastic signs in the light fittings as recommended by the manufacturer and approved by the Engineer.

D. Comply with the relevant requirements for placements and mounting heights for post mounted signs. Mounting height shall be 2100 mm from the kerb level to the lower edge of the sign unless shown or approved otherwise. Provide mounting posts with breakaway joints where required.

E. Treat all sign posts located in areas used by pedestrians with alternate 150mm wide bands of black paint and white reflective tape.

F. Protect aluminum by a bituminous coating where it is in contact with concrete. Protect portions of posts which are buried below ground by coating internally and externally with bitumen.

3.02 CLEANING

A. Upon completion of installations, clean soiled sign surfaces in accordance with manufacturer's instructions prior to handing over to the Employer.

3.03 PROTECTION

A. Delay the installation of work with exposed painted metal finishes, acrylic and graphics, wherever possible until other work which might damage such finishes has been completed. When such delay of installation is not possible, or would delay the project, protect such exposed work by maintaining suitable temporary coverings to ensure that no damage thereto will result from other work being performed.

2.9 RAMP FOR EXTERNAL SIDEWALK

External pedestrian ramp as per approved shop drawing to be submitted by the contractor based on site levels and conditions.

Work to include:

- Remove parts of sidewalk including curbstone and existing tiles
- Remove the debris to outside the site
- Supply and install concrete curbstone for the ramp
- Supply and install floor tiles identical to the existing with mortar and all layers
- All needed items as per the Engineer instructions

2.10 ASPHALT PAVING

PART 1 - GENERAL

SUMMARY

A. The extent of asphalt paving work and ancillaries is indicated on drawings.

B. This section includes:

1. Asphaltic concrete paving for roadways and car parks.
2. Line markings.

QUALITY ASSURANCE

A. Codes and Standards: Conform and comply with ASTM, AASHTO, BS or alternative equivalent standards acceptable to the Engineer, which establish minimum acceptable qualitative and quantitative requirements for asphalt concrete materials and paving execution.

B. Testing and Inspection Service: Contractor shall employ and pay for a qualified independent testing laboratory acceptable to the Engineer to perform specified testing and inspection as required by the Engineer in connection with asphalt.

C. Testing Laboratory Qualifications: To qualify for acceptance, the concrete materials and paving works testing laboratory must demonstrate to Engineer's satisfaction, that it has the experience and capability to conduct required field and laboratory testing without delaying the progress of the Work.

PART 2 - PRODUCTS

MATERIALS

A. Coarse Aggregate (retained on No. 8 ASTM Sieve) shall be first grade crushed rock conforming to the quality requirements of AASHTO M78-64 (1974) and of such grading that when combined with other required aggregate fractions in proper proportions, the resultant mixture will meet the grading required for the mix.

B. Fine aggregate (passing No. 8 ASTM Sieve) shall consist of stone screenings, natural sand or a combination of these two conforming to the quality requirements of ASTM D 1073-63 (1969) of such grading that when combined with other required aggregates in the proper proportions, the resultant mixture will meet the grading required for the mix.

C. Mineral filler, if used, shall meet the requirements of ASTM D 242 (AASHTO M17-70) and of the following grading:

ASTM Sieve	Percentage Passing
No. 30	100
No. 50	95 - 100
No. 100	90 - 100
No. 200	70 - 100

D. Asphalt cement shall conform to the requirements of AASHT0 M20-70 and the amount required shall be between 3.5 and 7.0 percent of the total mix by weight. It shall be 85-to 100-penetration grade approved by the Engineer.

ASPHALT CONCRETE MIXES

A. Sample mixes and trial areas will be required to confirm the suitability of the Contractors proposals to achieve the pigmentation and authorization will be given by the Engineer in writing when a satisfactory method has been established and successful trials have been concluded.

B. The mix shall be composed of a mixture of aggregate, filler if required, and bituminous material. The several aggregate fraction shall be sized, uniformly graded and combined in such proportions that the resulting mixture meets the following grading requirements.

1. Grading of Total Aggregate (coursing plus fine plus filler) Percentage passing by weight:

Sieve Size ASTM E 323	Base Course	Wearing Course
1-1/2 inch	100	-
1 inch	80 - 100	-
3/4inch	70 - 90	100
1/2 inch	-	80 - 100
3/8 inch	55 - 75	-
No. 4	44 - 62	50 - 70
No. 10	33 - 48	32 - 47
No. 40	16 - 27	16 - 26
No. 80	-	10 - 18
No. 200	3 - 10	4 - 10

C. The Contractor shall submit to the Engineer for approval, at least 30 days before commencement of the asphalt operations a mix test results to conform to the following criteria.

1. Asphalt Concrete Base Course:
   a. Stability: 300 kg minimum (75 blows)
   b. Flow: 2.4 - 5.0 mm
   c. Air Voids: 3.0 - 7.0%
   d. Voids Filled with Asphalt: 60 - 75

2. Asphalt Concrete Surface Course:
   a. Stability : 450 kg minimum (75 blows)
   b. Flow : 2.4 - 4.0 mm
   c. Air Voids : 3.0 - 5.0%
   d. Voids filled with Asphalt : 70 - 80%

D. Loss of material stability by submerging specimens in water at 60°C for 24 hours as compared to stability measured after submersion in water at 60°C for 20 minutes not to exceed 25%, for each asphalt concrete mix designation.

E. The mix submitted shall establish single percentages for the coarse aggregate, fine aggregate, aggregate passing the No. 200 Sieve, the amount of asphalt cement, the temperature leaving the mixer and the temperature delivered on the road. The mixture subsequently furnished by the Contractor shall conform to this job-mix formula within the following range of tolerances.

1. Maximum variations of material passing:

Sieve No. 4 and larger	±5%	
Sieve No. 10 to No. 100		±5%
Sieve No. 200	±1.5%	
Asphalt content	+0.3	
Temperature at mix discharge	±10°C	
Temperature at laying		+5°C

F. If unsatisfactory results make it necessary or when a new source of material is proposed, the Engineer may establish a new job-mix formula and so notify the Contractor in writing before the new material is used.

APPLICABLE CODES AND STANDARDS

ASTM DS	Test for Penetration of Bituminous Materials
ASTM D242	Mineral Filler for Bituminous Paving Mixtures
ASTM D979	Sampling of Bituminous Paving Mixtures
ASTM D2172	Quantitative Extraction of Bitumen from Bituminous Paving
ASTM C136	Sieve Analysis of Fine and Coarse Aggregate
ASTM D1188	Bulk Specific Gravity of Compacted Bituminous Mixtures
ASTM D1559	Resistance to Plastic Flow of Bituminous Mixtures
ASTM D3549	Thickness of Height of Compacted Bituminous Paving Mixtures
ASTM D3203	Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures

PART 3 - EXECUTION

MIXING PLANT

A. The asphalt mixing plant that is used for heating, proportioning and mixing the aggregates and asphalt cement, which may be of either the batch type or continuous mixing type, shall be capable of producing a uniform mixture in the quantities required within the job-mix tolerance specified previously, and shall be subject to approval by Engineer.

B. The plant shall be provided with an accurate mechanical means and positive control for drying, heating and

feeding the mineral aggregate at a uniform temperature. The feeder or feeders shall be capable of delivering in precise proportions the aggregate or aggregates required.

C. Tanks used for storage of asphalt cement shall be of sufficient capacity and be provided with a device for controlled heating of the material temperature between 220°F and 270°F (105°C and 130°C). Heating shall be accomplished so that no flame shall come in contact with the heating tank. A circulating system of adequate size to insure proper and continuous circulation between the storage tank and mixer during the entire operating period shall be provided. When possible, the discharge end of the circulating pipeline shall be kept below the surface of the asphalt in the tank while the pump is in operation.

D. Means shall be provided to obtain the required percentage of asphalt in the mix within the tolerances specified, either by weighing or measuring volumetrically. Where the quantity of asphalt is controlled by metering, provisions shall be made for the amount of asphalt delivered through the meter to be readily checked by weight. Steam jacketing or other insulation, which will maintain the specified temperature of asphalt in pipelines, meter, weigh buckets, spray bars, flow lines or other containers, shall be provided.

MIXING

A. The aggregate for the mixture shall be dried and heated to the required temperature. Flames used for drying and heating shall be properly adjusted to avoid damage to and root on the aggregate.

B. The dried heated aggregates shall be combined in the mixer in the amount of each fraction of aggregates required to meet the job-mix formula. The bituminous material shall be measured and introduced into the mixer in the amounts specified. After the required amounts of aggregates and bituminous material have been introduced into the mixer, the material shall be mixed until a complete and uniform coating of the particles throughout the aggregate is secured. Wet mixing time will be approved by the Engineer for each type of plant and for each type of aggregate used. The mixture shall be produced as closely as practicable to the lower temperature, which will produce a workable mix within the specified temperature range.

TRANSPORTATION, LAYING AND COMPACTION OF ASPHALT

A. Before laying the bituminous concrete base course check road base to ensure that the surface is within the specified tolerance and is in all respects fit for laying the pavement. The surface is then to be sprayed with bituminous prime coat.

B. The bituminous prime coat shall be cut-back bitumen MC30 or MC70 applied at the rate of 0.5 to 1.5 litres/m2.

C. The prime coat shall be applied only when the road base has been approved by the Engineer and the surface is dry or slightly damp.

D. The cut-back bitumen shall be applied by a pressure distributor so that uniform distribution is obtained at all points. A disposable protective covering such as thick paper or polythene shall be spread back from the end of each application to cover the existing surfaces. The flow through the nozzles shall be started and stopped on the disposable protective covering so that all nozzles are operating properly on the entire length being treated. During application to surfaces adjacent to walkways and other structures all objects shall be protected so as to prevent their being spattered or marred. No bituminous material shall be allowed to discharge into a ditch or stream.

E. Laying of the base course shall not be commenced until the prime coat has been absorbed by the surface and approval given by the Engineer.

F. The tack coat between the base course and wearing course is to be rapid curing cut-back Bitumen RC250 (AASHTO M81-70) applied at a rate of 0.5 to 1.5 litres/sq.m or as directed by the Engineer.

G. The asphalt concrete mixtures shall be transported from the mixing plant to the laying plant in metal lined lorries, or such other vehicles as may be approved by the Engineer. No loads shall be delivered so as to prevent completion of the spreading and compaction during daylight hours. The mixture shall be delivered at a

temperature between 220°F and 270°F (105°C and 130°C) and within 20°F (10°C) of the temperature specified in the job-mix formula. No segregation of the material or excess loss of heat is to occur during transport.

H. Unless otherwise approved by the Engineer, asphaltic concrete is to be laid by paving machine in layers indicated or as otherwise required. The machine must be capable of producing a level and even running surface and must correct for any irregularities in the base. Paving machines must be capable of feeding material from the hopper across the full width of the screed.

I. When making longitudinal joints, the layer should overlap the existing strip by about 50 mm. Sufficient depth of material is to be left on the overlap to allow for compaction. The excess material is to be removed by brooming or raking but care is to be taken to avoid over-raking. As soon as raking is complete, the joint is to be well rolled. If the abutting lane is not placed on the same day, the joint is to be cut back to an even line, preferably by means of a cutting blade attached to the roller. The joint is then to be given a very light coat of bitumen before the next strip is placed.

J. After spreading, the mix is to be thoroughly compacted by rolling. The initial "breakdown" rolling is to be carried out by three wheeled rollers with a weight per mm width of rear wheel between 4.4 and 6.5 kg. The rollers are to proceed onto fresh material with rear or driven wheels leading. When the rollers are reversed at the end of pass, the steering wheels are to be on compacted material and their movement in changing direction is not to displace the mix. After the initial rolling, compaction is to be achieved by pneumatic tyred rollers which are to be self propelled having a weight of between 15 and 30 tonne and tyre pressure which can be varied between 0.05 and 0.08 kg/mm2. This pneumatic tyre rolling to be carried out immediately following the initial rolling and while the mix is still warm between 175°F and 220°F (80°C and 105°C). After the pneumatic tyre rolling, a final finish may be given by tandem roller.

K. Each pass of the roller is to overlap the preceding one by half the width of the roller wheel. Alternate passes of the roller are to be slightly varying lengths. The rolling speed is to be about 3km per hour, and the number of passes is to be about 5 or 6 over the same area. The roller wheels are to be clean and smooth and care is to be taken to ensure that the mixture does not adhere to the wheels. Rolling is to commence as soon as the freshly spread mix will bear the weight of the roller without any endure movement or displacement and on no account are the rollers to be allowed to stand on the finished surface until it has thoroughly cooled. Immediately following initial rolling, the surface to be checked with a straight edge to ensure that it meets with the tolerance requirements. Minor variations may be corrected by rolling, but larger imperfections are to be adjusted by adding or taking away mix while it is still hot and workable.

TESTING OF ASPHALT MATERIALS AND SURFACES

A. Perform the following tests as directed by the Engineer:

1. Uncompacted Asphalt Concrete Mix:
   a. Sampling — ASTM D 979
   b. Asphalt cement content — ASTM D 2172
   c. Sieve analysis of extracted mineral matter — ASTM D 313, ASTM C 136
   d. Penetration of recovered asphalt cement — ASTM D 5
   e. Ductability of recovered asphalt cement — ASTM D 113
   f. Marshall stability and flow — ASTM D 1159
   g. Perform at least one test for each day's paving.

2. Compacted Asphalt Concrete Mix:
   a. Bulk density — ASTM D 1188
   b. Marshall stability and flow — ASTM D 1559
   c. Thickness or height of compacted mix — ASTM D 3549
   d. Air voids in compacted mix — ASTM D 3203

B. Compacted mix cut samples as directed by the Engineer from installed paving. Supply and compact new material in the voids left by the sampling. The samples will be tested as directed by the Engineer and the specific gravity shall be not less than 95% of the specific gravity of laboratory compacted specimens composed of the same materials in like proportions.

C. Uncompacted mix test the bituminous mixture ... daily to ensure compliance with the approved job-mix formula. Submit copies of the test results to the Engineer.

D. Finished Surfaces: Test with a 3 meter straight edge applied both parallel and at right angles to the centerline of the road. Check and test surfaces under the direction of the Engineer. Variation of the surface from the testing edge of the straight edge between any two contacts with the surface shall not exceed 3mm.

LINE MARKINGS

A. Preparation: Sweep clean surface to eliminate loose material and dust.

B. Material: Factory mixed quick drying and non-bleeding purpose made chlorinated rubber based traffic and lane marking paint approved by the Engineer.

1. Suitability: for road surface temperatures of up to 80 deg. C.
2. Color: white.

C. Execution: Apply markings and lines strictly in accordance with manufacturer's instructions to the approval of the Engineer.

2.11 FLAGPOLE

PART 1 : GENERAL

SUMMARY

A. Aluminum flagpole as shown on attached drawing with all components as needed for a complete installation.

PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide flagpoles capable of withstanding the effects of wind loads according to ANSI/ NAAMM FP 1001-07, “Guide Specifications for Design of Metal Flagpoles”, which specifies the winds loads on the pole with flag flying, to a specified wind speed 140 km/hr minimum with unflagged windspeeds of 160 km/hr.

B. Flagpole Design: Design shall be based on standard size polyester flag suitable for use with pole.

SUBMITTALS

A. Product Data: For each type of flagpole required, submit manufacturer’s technical data and standard instructions.

B. Shop Drawings: Show general layout, jointing anchorage, support systems, foundations and accessories.

C. Structural Calculation and Structural Analysis Data: Required to be provided if requested by consultant / owner. Detailed calculations performed in accordance with ANSI/NAAMM FP 1007-01 are necessary for any alternative proposed flagpole with geometry differing from recommended specifications.

D. Samples: Finish samples for each finished metal used on flagpoles, as may be required

QUALITY ASSURANCE

A. Source: Obtain each flagpole as a complete unit from flagpole manufacturer / authorized dealer, including fittings, accessories, bases, and anchorage devices.

B. Installer Qualifications:

   a. Five years' experience installing flagpoles of similar height and complexity in locale of the project.

   b. Authorized and trained by flagpole manufacturer.

PART 2 : PRODUCTS

FLAGPOLE TYPE AND CONSTRUCTION

A. Aluminum Flagpole Construction

   Fabricate flagpole shaft from extruded aluminum tubing with no visible seam, complying with ASTM B221. Flagpole shafts shall be fabricated from 6063 alloy in a T4 temper, tapered, and welded with 4043 filler alloy (for base plate, door assembly, and cap), and heat treated to a T6 temper after fabrication and welding.

   a. Flagpole shaft shall be cone-tapered, per manufacturer's standard rate of taper.

   b. Shoe-type Base Plate: Base Plate shall be appropriately sized for the flagpole, and shall be welded to the shaft at the factory prior to heat treating to T6 Temper.

   c. Shaft shall be fitted with a cast aluminum top plug, drilled and threaded for connection of truck assembly; and shall include reinforced handhold opening with flush fitting aluminum door with locking style closure; and internal plate for mounting a cam-cleat.

B. Assembly Features / Model: Internal Rope Halyard, Revolving Truck Assembly with Cam Cleat - Shoe Base Mounting, and flush access door. Designed in accordance with ANSI/NAAMM FP-1001-07 for performance requirements.

MOUNTING

Shoe Base: Cast aluminum shoe base will be anchored to a concrete foundation block using four hot-dipped galvanized steel anchor bolts, M24 x 550mm Grade 8.8 or Equivalent, to be cast into the foundation.

FITTINGS

A. Finial Ball (Ornament) and Revolving Cone-Style Top Hat Truck Assembly for Internal Halyard:
   a. Ball (Ornament): Spun Aluminum, Gold Tone Anodized spherical ball, size to match pole butt diameter.
   b. Cone Style Top Hat Truck Assembly: Internal Halyard, revolving truck assembly, made of a cast aluminum housing; with dual sealed stainless steel spindle bearings; and aluminum internal pulley assembly, and bronze halyard exit bushing.

B. Internal Halyard Cam Cleat System: Provide one (1) complete internal halyard cam cleat rope assembly with plastic coated counterweight and beaded sling assembly.

C. Flash Collar: Provide Spun Aluminum Collar to match flagpole. Aluminum collar is to be the same finish as the flagpole shaft, to cover the base plate and bolts to provide a more decorative appearance.

PART 3 : EXECUTION

PREPARATION

Foundation: Provide cast-in-place foundation as per Manufacturer's recommended design. Excavate to neat clean lines in undisturbed soil. Remove loose soil and foreign matter from excavation and moisten earth before placing concrete. Secure anchor bolts in position with templates and brace to prevent displacement during concreting. Place concrete immediately after mixing.. Trowel exposed concrete surfaces to a smooth, dense finish, free of trowel marks and uniform in texture and appearance. Provide positive slope for water runoff to base perimeter.

FLAGPOLE INSTALLATION

A. General: Install flagpoles where shown and according to shop drawings.

B. Shoe Base Installation: Place flagpole on top of the installed anchor bolts / leveling nut and washer, and fix using flat washer, and hex nut. Tighten nut and verify that all threads are fully engaged. Cover with decorative flashing collar.

C. Test halyard system / flag hoisting mechanism in accordance with manufacturer's written instructions. Ensue that counterweight, retaining ring, and other components are installed correctly and that the truck assembly rotates properly.

CHAPTER THREE
CONCRETE WORKS

3.1 CAST IN PLACE CONCRETE

PART 1 - GENERAL

SUMMARY

A. Extent of cast in place concrete work is shown on Drawings.

PROJECT CONDITIONS

A. Protect adjacent finish materials against spatter during concrete placement.

B. Protection of fresh concrete against hot weather: Cover completed fresh concrete with temporary cover as required to protect newly cast elements from direct sun light in hot weather - above 35 deg. C; maintain cover for time period until curing starts.

C. Protect surfaces from rain, wind and sun, detention and physical damage.

D. Protect immature concrete from physical shock, movement, thermal shock and cold water.

PART 2 - PRODUCTS

REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615; BS 4449, 4461

B. Steel Wire: ASTM A 82, plain, cold-drawn steel.

C. Welded Wire Fabric: ASTM A 185; BS 4483

D. Supports for Reinforcement; Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place.

1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.

2. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs which are plastic protected or stainless steel protected.

CONCRETE MATERIALS

A. Ordinary Portland cement: ASTM C 150 Type I; BS12.

B. Sulphate-Resisting Portland cement: ASTM C 150 Type V; BS 4027

C. Use one brand of cement throughout project, unless otherwise acceptable to Engineer.

D. Normal Weight Aggregates: ASTM C 33; BS 882 and as herein specified. Provide aggregates from a single source for exposed concrete.

1. Do not use fine or coarse aggregates containing spalling-causing deleterious substances and this should have a sand equivalent more than 70.

2. Local aggregates not complying with the standards stated but which have shown by special test or actual service to produce concrete of adequate strength and durability may be used when acceptable to Engineer.

E. Hourdi Blocks for hollow concrete suspended slabs: Machine made vibrated hollow concrete (cement and fine sand aggregate) blocks, withstanding compressive force applied at the ends of 40kg/cm2 based on the gross sectional area of the block (without deducting voids).

F. Water: Potable, free from foreign material in amounts harmful to concrete or embedded steel.

RELATED MATERIALS

A. Epoxy Adhesive: ASTM C 8891, two component material suitable for use on dry or damp surfaces. Provide material "Type", "Grade", and "Class" to suit project requirements.

PROPORTIONING AND DESIGN OF MIXES

A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If trial batch method used, use an independent testing facility acceptable to Engineer for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing.

B. For information, submit written reports to Engineer of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until the acceptability of each mix has been adequately substantiated by the Contractor according to ACI 301, as judged by the Engineer.

C. Design mixes in accordance with the following table. Ensure quantity of water used does not exceed that required to produce a concrete with sufficient workability to be placed and compacted where required.

DESIGNED MIXES

Class of Concrete	AA	A	B	C
Minimum cement quantity per m3 of concrete (kg)	450	400	350	250
Water cement ratio	0.48	0.48	0.49	0.58
Preliminary Test Cylinders: Minimum Compressive Strength at 28 Days (kg/cm2)	400	350	280	180
Works Test Cylinders Minimum: Compressive Strength at 28 Days (kg/cm2)	350	300	250	175
Method of compacting of concrete when placed	Vibrated	Vibrated	Vibrated	Rodded, or

Class of Concrete	AA	A	B	C
				Tamped

Keep slump to the minimum compatible with approved placing requirements.

D. Adjustment to Concrete Mixes: Mix design adjustments may be requested from Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to Employer and as accepted by Engineer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Engineer before using in work.

E. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:

1. Ramps, slabs, and sloping surfaces: Nor more than 100mm.

2. Reinforced foundation systems: Not less than 25 mm and not more than 125 mm.

3. Concrete containing HRWR admixture (super-plasticizer): Not more than 230 mm after addition of HRWR to site-verified 50-75 mm slump concrete.

CONCRETE MIXING

A. Provide batch ticket for each batch discharged and used in work, indicating project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.

B. Ready-Mix Concrete: Comply with requirements of ASTM C 94, and as herein specified.

C. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C 94 may be required and shall be subject to the Engineer's approval.

PART 3 - EXECUTION

GENERAL

A. Coordinate the installation of joint materials and water proofing membranes with placement of forms and reinforcing steel

FORMS

A. Design, erect, support, brace, and maintain formwork to support vertical and lateral, static, and dynamic loads that might be applied until such loads can be supported by concrete structure. Construct formwork so concrete members and structures are of correct size shape, alignment, elevation, and position. Maintain formwork construction tolerances complying with ACI 347.

B. Design formwork to be readily removable without impact, shock, or damage to cast-in-place concrete surfaces and adjacent materials.

C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways. reglets, recesses, and the like, to prevent swelling and for easy removal.

D. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately

place and securely support items built into forms.

PLACING REINFORCEMENT

A. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports, and as herein specified.

1. Avoid cutting or puncturing water proofing membranes during reinforcement placement and concreting operations.

B. Clean reinforcement of loose rust and mill scale, earth, and other materials, which reduce or destroy bond with concrete

C. Accurately position, support, and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.

D. Place reinforcement to obtain at least minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surface.

E. Install welded wire fabric in as long lengths as practicable. lap adjoining pieces at least one full mesh and lace splices with wire. Offset end laps in adjacent widths to prevent continuos laps in either direction.

JOINTS

A. Construction Joints: Locate and install construction joints as indicated or, if not indicated, locate so as not to impair strength and appearance of the structure, as acceptable to Engineer.

1. Where specific slab-on-ground construction joints are not shown on Drawings, cast slab on ground in strips, each strip width not to exceed 5 m or the typical bay width whichever is less.

2. Construction joint spacing in basement walls and slabs on ground should not exceed 8m unless acceptable to Engineer.

3. Locate construction joints in framed slabs within the middle third of any slab or beam span length, unless otherwise indicated on drawings.

4. Lightly roughen face to expose coarse aggregate unless otherwise instructed. Wet and cover with 1:1 cement and sand grout immediately prior to placing fresh concrete. Stop roughening 25 mm form arises to surfaces exposed to view in finished work. Remove small mortar lips from exposed arises with carborundum stone. Face is to be clean and damp before fresh concrete is placed against it.

B. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints, except as otherwise indicated.

C. Waterstops: Provide waterstops in construction joints as indicated. Install waterstops to form continuous diaphragm in each joint. Make provisions to support and protect exposed waterstops during progress of work. Fabricate field joints in waterstops in accordance with manufacturer's printed instruction.

D. Isolation Joints in Slabs-on-Ground: Construct isolation joints in slabs-on-ground at points of contact between slabs-on-ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.

1. Joint filler and sealant materials are specified in elsewhere in the specifications.

CONCRETE PLACEMENT

A. Replacement Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast-in. Notify other trades to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where form coatings are not used.

1. Apply temporary protective covering to lower 600 mm of finished walls adjacent to poured floor slabs and similar conditions, and guard against spattering during placement.

B. General: Comply with ACI 304 "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete", and as herein specified.

C. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation..

D. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 600 mm and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.

E. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309.

F. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not further than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 150 mm into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.

G. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.

H. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.

I. Bring slab surfaces to correct level with straightedge and strike off. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.

J. Maintain reinforcing in proper position during concrete placement operations.

K. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as herein specified.

L. When air temperature has fallen to or is expected to fall below 36 deg F (2 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C), and not more than 80 deg F(27 deg C) at point of placement.

M. Do not use-frozen material or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

N. Do not use calcium chloride, salt, and other materials containing antifreeze agents or chemical accelerators, unless otherwise accepted in mix designs.

O. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.

P. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg (32 deg C). Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is calculated to total amount of mixing water. Use of liquid nitrogen to cool concrete is Contractor's option.

Q. Cover reinforcing steel with water-soaked burlap it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.

R. Fog spray forms, reinforcing steel, and sub grade just before concrete is placed.

S. Use water-reducing retarding admixture (Type D) when required by high temperatures, low humidity, or other adverse placing conditions.

CONCRETE CURING AND PROTECTION

A. General: Protect freshly placed concrete from direct exposure to wind, from premature drying and from excessive cold or hot temperatures.

B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Keep continuously moist and covered for not less than 7 days.

C. Begin final curing procedures immediately following initial curing and before concrete have dried. Continue final curing for at least 7 days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.

D. Curing methods: Perform curing of concrete by curing and sealing compound, by moist curing, by moisture-retaining cover curing, and by combinations thereof, as herein specified.

E. Provide moisture curing by following methods.

1. Keep concrete surface continuously wet by covering with water.

2. Continuous water-fog spray.

3. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 100 mm lap over adjacent absorptive covers.

F. Cover concrete surfaces with moisture retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 74 mm and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

G. Provide membrane curing and sealing compound to exposed interior slabs and to exterior slabs, walks, and curbs, as follows:

1. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours). Apply uniformly in continuous operation by power-spray or roller in accordance with manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.

H. Do not use membrane curing compounds on surfaces which are to be covered with coating material applied directly to concrete, liquid floor hardener, waterproofing, damp proofing, membrane roofing, flooring (such as ceramic or quarry tile, glue-down carpet), painting and other coatings and finish materials, unless otherwise acceptable to Engineer.

I. Curing Formed Surfaces: Cure formed concrete surfaces, including undersides of beams, supported slabs, and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above as applicable.

J. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by application of appropriate curing method.

K. Final cure concrete surfaces to receive liquid floor hardener or finish flooring by use of moisture-retaining cover, unless otherwise directed.

SHORES AND SUPPORTS

A. Comply with ACI 347 for shoring and reshoring in multistory construction, and as herein specified.

B. Remove shores and reshore in a planned sequence to avoid damage to partially cured concrete. Locate and provide adequate reshoring to safely support work without excessive stree or deflection.

C. Keep reshores in place a minimum of 15 days after placing upper tier, and longer if required, until concrete has attained its required 28-day strength and heavy loads due to construction operations have been removed.

REMOVAL OF FORMS

A. Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at no less than 50 deg F (10 deg C) for 36 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.

B. Formwork supporting weight of concrete, such as beam soffits, joists, slabs, and other structural elements, may not be removed in less than 14 days and not until concrete has attained 28 day design strength unless authorized by Engineer. Determine potential compressive strength of inplace concrete by testing field-cured specimens representative of concrete location or members.

C. Form facing material may be removed 4 days after placement, only if shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and supports.

RE-USE OF FORMS

A. Clean and repair surfaces of forms to be re-used in work. Split, frayed, delaminated, or otherwise damaged form facing material will not be acceptable for exposed surfaces. Apply new form coating compound as specified for new formwork.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use "patched" forms for exposed concrete surfaces, except as acceptable to Engineer.

MISCELLANEOUS CONCRETE ITEMS

A. Filling-In: Fill-in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place, and cure concrete as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations, as shown on drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer machines and equipment.

D. Grout base plates and foundations as indicated, using specified non-shrink grout. Use non-metallic grout for exposed conditions, unless otherwise indicated.

E. Steel Pan Stairs: Provide concrete fill for steel pan stair treads and landings and associated items. Cast-in-safety inserts and accessories as shown on drawings. Screed, tamp, and finish concrete surfaces as scheduled.

QUALITY CONTROL TESTING DURING CONSTRUCTION

A. The Contractor will employ a testing laboratory approved by the Engineer to perform tests and to submit test reports.

B. Sampling and testing for quality control during placement of concrete may include the following, as directed by Engineer.

C. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.

1. Slump: ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.

2. Concrete Temperature: Test hourly when air temperature is 40 deg F (4 deg C) and below, and when 80 deg F (27 degC) and above; and each time a set of compression test specimens is made.

3. Compression Test Specimen: ASTM C 31; one set of 6 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field - cured test specimens are required.

4. Compressive Strength Tests: ASTM C 39, one set for each day's pour exceeding 4 cu.m plus additional sets for each 40 cu.m over and above the first 20 cu.m of each concrete class placed in any one day; two specimens tested at 7 days, three specimens tested at 28 days, and one specimen retained in reserve for later testing if required.

5. When frequency of testing will provide less than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.

6. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.

7. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results exceed 10% of specified compressive strength, and no individual strength test result falls below specified compressive strength by more than 3.5 MPa (500 psi)

D. Test results will be reported in writing to. Engineer within 24 hours after tests. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7-day tests and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.

F. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Engineer. Testing service may conduct test to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. Contractor shall pay for such additional tests.

3.1.1 WATERSTOPS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Extent CONTRACTOR shall furnish and securely install expanding rubber waterstops where shown or specified in the DRAWINGS. The WORK includes cleaning of concrete surfaces and installation of expanding rubber waterstop.

1.02 SUBMITTALS

A. Provide product data for the following:

1. Waterstop Product.

2. Adhesive.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Deliver the waterstop materials to the PROJECT site in the manufacturer's unpacked containers with all labels intact and legible at time of use. Materials shall be stored in a secure, indoor, dry area. Maintain the waterstops in a dry condition during delivery, storage, handling, installation, and concealment.

PART 2 - PRODUCT

2.01 MATERIALS

A. Hydrophilic Rubber Waterstop:

1. The waterstop shall have the minimum performance standard of:

Property	ASTM Standard	Results
Tensile Strength (MPa)	D412	0.98
Elongation	D412	550
Hardness (Hs)	D2240	30 Durometer Type A
The time period to maximum volume expansion is 35 days.		

2. Materials approved for use are:

a. Adeka Corporation; MC-2010M.
b. Adeka Corporation; KM-3030M.
c. Adeka Corporation; P201 (except in contact with potable water).
d. Adeka Corporation; KC Series.

B. Adhesive:

1. The adhesive shall be 3M-2141 as manufactured by the 3M Company, or Adeka Corporation H-1000 Ultra Bond or an approved equivalent.

PART 3 - EXECUTION

3.01 GENERAL

A. Ensure proper execution of the waterstop installation.

B. The components and installation procedures shall be in accordance with the manufacturer's printed specifications and recommendations. Installation shall be performed by skilled workers who are trained in procedures and methods required for proper performance of the waterstop.

3.02 EXAMINATION

A. Examine the concrete surface and correct any surface imperfections which may prevent proper installation and performance of the waterstop. The finished concrete surface, prior to surface preparation, shall be equal to a steel trowel finish.

3.03 SURFACE PREPARATION

A. Concrete surfaces shall be clean and free of dirt, saw dust, laitance, grease, form oils, form release agent, or other contamination to ensure proper adhesion of the waterstop to the concrete surface. Use a wire brush to lightly roughen the surface. Remove all concrete dust with a soft brush.

3.04 WATERSTOP PLACEMENT

A. Measure and cut an exact length of waterstop. Splices are not permitted in the waterstop in vertical wall joints of structures. Splices in horizontal joints are acceptable, however, only one (1) splice is permitted in twenty five (25) feet. Splice of waterstops in horizontal joints shall be made by butting and gluing the ends of the waterstop with an approved adhesive.

B. Refer to the manufacturer's recommendations for minimum clearance to a concrete face. Unless a greater clearance is recommended by the manufacturer, the minimum clearance shall be two (2) inches. Use the greater clearance if the recommended clearance is more than two (2) inches.

C. Using a brush, apply a uniform coat of adhesive to the concrete surface along the line of placement. Apply a uniform coat of adhesive to the waterstop. Gaps in the glue application shall not be permitted.

D. After the adhesive has dried to a tacky condition (about fifteen [15] minutes in the summer and thirty [30] minutes in the winter), firmly press the waterstop to the concrete surface. When installing the waterstop on curved surfaces such as pipes, temporary bands (for example, wire or rope) may be used to assist in securing the waterstop to the surface. Any temporary means of securing the waterstop shall be removed prior to placing concrete or grout.

E. Concrete placement within twelve (12) hours is required. The waterstop shall be protected from water and from displacement prior to concrete placement. During concrete placement, CONTRACTOR shall visually observe the waterstop to ensure proper placement and alignment.

3.2 CONCRETE TOPPING (STAMPED CONCRETE)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Decorative stamped concrete floor topping.

1.2 ACTION SUBMITTALS

A. Product Data: product indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Product test reports.

PART 2 - PRODUCTS

2.1 CONCRETE FLOOR TOPPINGS

A. Stamped-Aggregate Concrete Floor Topping: Factory-prepared and dry-packaged mixture of containing mineral oxide; portland cement; plasticizers; and other admixtures to which only water needs to be added at Project site.

   1. Products: Subject to compliance with requirements, provide available products that may be incorporated into the Works and which are deemed in the market.
      a. Compressive Strength (28 Days): 4000 psi; ASTM C 109/C 109M
      b. Slump in concrete shall not exceed 10 cm

2.2 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately (305 g/sq. m) when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 25 percent solids content, minimum.

F. Apply a color hardener at the minimum 30 kg / 10 sq.m

2.3 RELATED MATERIALS

A. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, [**epoxy resin with a Type A Shore durometer hardness of 80**] per ASTM D 2240.

B. Joint-Filler Strips: [**ASTM D 1751, asphalt-saturated cellulosic fiber**].

C. Portland Cement: ASTM C 150, Type I or II.

D. Sand: ASTM C 404, fine aggregate passing No. 16 (1.18-mm) sieve.

E. Water: Potable.

F. Acrylic-Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

G. Epoxy Adhesive: ASTM C 881/C 881M, Type V, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements.

2.4 MIXING

A. Bonding Slurry: Mix portland cement with water to a thick paint consistency.

B. Bonding Slurry: Mix 1 part portland cement and [**1-1/2**] parts sand with water [**and an acrylic-bonding agent according to manufacturer's written instructions**] to a thick paint consistency.

C. Floor Topping: Mix concrete floor topping materials and water in appropriate drum-type batch machine mixer or truck mixer according to manufacturer's written instructions.

PART 3 - EXECUTION

3.1 PREPARATION

A. Existing Concrete: Remove existing surface treatments and deteriorated and unsound concrete. Mechanically abrade base slabs to produce a heavily scarified surface profile with an amplitude of (6 mm).

1. Prepare and clean existing base slabs according to concrete floor topping manufacturer's written instructions. Fill voids, cracks, and cavities in base slabs.

2. Saw cut contraction and construction joints in existing concrete to a depth of (35-50 mm) and fill with semirigid joint filler.

3. To both sides of joint edges and at perimeter of existing base slab [**mechanically remove a (100-mm-) wide and (0- to 25-mm-) deep, tapered wedge of concrete and retexture surface**].

B. Install joint-filler strips where topping abuts vertical surfaces.

3.2 FLOOR TOPPING APPLICATION

A. Start floor topping application in presence of manufacturer's technical representative.

B. Monolithic Floor Topping: After textured-float finish is applied to fresh concrete of base slabs specified in Division 03 Section "Cast-in-Place Concrete," place concrete floor topping while concrete is still plastic.

C. Deferred Floor Topping: Within 72 hours of placing base slabs, mix and scrub bonding slurry into dampened concrete to a thickness of (1.6 to 3 mm), without puddling. Place floor topping while slurry is still tacky.

D. Existing Concrete: Apply epoxy-bonding adhesive, mixed according to manufacturer's written instructions, and scrub into dry base slabs to a thickness of (1.6 to 3 mm), without puddling. Place floor topping while adhesive is still tacky.

E. Place concrete floor topping continuously in a single layer, tamping and consolidating to achieve tight contact with bonding surface. Do not permit cold joints or seams to develop within pour strip.

1. Screed surface with a straightedge and strike off to correct elevations.
2. Slope surfaces uniformly where indicated.
3. Begin initial floating using bull floats to form a uniform and open-textured surface plane free of humps or hollows.

F. Finishing: Consolidate surface with power-driven floats as soon as concrete floor topping can support equipment and operator. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until concrete floor topping surface has a uniform, smooth, granular texture.

1. Hard Trowel Finish: After floating surface, apply first trowel finish and consolidate concrete floor topping by power-driven trowel without allowing blisters to develop. Continue troweling passes and restraighten until surface is smooth and uniform in texture.

G. Construction Joints: Construct joints true to line with faces perpendicular to surface plane of concrete floor topping, at locations indicated or as approved by Architect.

1. Coat face of construction joint with epoxy adhesive at locations where concrete floor topping is placed against hardened or partially hardened concrete floor topping.

H. Contraction Joints: Form weakened-plane contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut (5-mm-) wide joints into concrete floor topping when cutting action will not tear, abrade, or otherwise damage surface and before random contraction cracks develop.
1. Form joints in concrete floor topping over contraction joints in base slabs, unless otherwise indicated.
2. Construct contraction joints for a combined depth equal to topping thickness and not less than one-fourth of base-slab thickness.
3. Construct contraction joints for a depth equal to one-half of concrete floor topping thickness, but not less than (13 mm) deep.

3.3 PROTECTING AND CURING

A. General: Protect freshly placed concrete floor topping from premature drying and excessive cold or hot temperatures.

B. Evaporation Retarder: Apply evaporation retarder to concrete floor topping surfaces in hot, dry, or windy conditions before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying floor topping, but before float finishing.

C. Begin curing immediately after finishing concrete floor topping. Cure by one or a combination of the following methods, according to concrete floor topping manufacturer's written instructions:

1. Moisture Curing: Keep surfaces continuously moist for not less than 7 days.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete for not less than seven days.
3. Curing Compound: Apply uniformly in two coats in continuous operations by power spray or roller according to manufacturer's written instructions.

3.4 JOINT FILLING

A. Prepare and clean contraction joints and install semirigid joint filler, according to manufacturer's written instructions, once topping has fully cured.

B. Install semirigid joint filler full depth of contraction joints. Overfill joint and trim semirigid joint filler flush with top of joint after hardening.

3.5 REPAIRS

A. Defective Topping: Repair and patch defective concrete floor topping areas, including areas that have not bonded to concrete substrate.

CHAPTER FOUR
MASONRY

4.1 HOLLOW OR SOLID CONCRETE BLOCKS AND CLOSTRA

PART 1 - GENERAL

DESCRIPTION OF WORK

A. Extent of each type of masonry work is indicated on Drawings.

B. Types of masonry work required include:

1. Concrete unit masonry.

QUALITY ASSURANCE

A. Unit Test Methods: Test the following materials by sampling and batch methods indicated

1. Concrete Masonry Units: Batch test sample blocks for compressive strength whenever required by the Engineer. Each test will comprise the destructive testing of twelve sample blocks selected by the Engineer. The minimum compressive strength for the gross area of any hollow block shall be 20 kg/cm2, and the average compressive strength for the gross area of all twelve blocks together shall be not less than 35 kg/cm2. If a test does not meet the compressive strength requirements, the entire batch from which the samples were selected will be rejected and removed from the site.

2. Mortars and Grouts: Test no less frequently than is required to evaluate mortars and grouts used to install each batch of masonry units from which samples are taken for testing.

PART 2 - PRODUCTS

MASONRY UNITS

A. General: Comply with referenced standards and other requirements indicated below:

1. Provide concrete masonry unit special shapes where required for corners, jambs, sash, control joints, headers, bonding and other special conditions.

a. Provide square-edged units for outside corners, except where indicated otherwise.

B. Concrete Blocks: Provide units complying with characteristics indicated below:

1. Manufacture: produce blocks from cement and sand 1:5 mix (300 kg cement to 1m3 sand) in vibrated pressure machine moulds. Adjust the mix as necessary to achieve compressive strength requirements.
2. Size: Manufacturer's standard units with nominal face dimensions of 400mm long x 200 mm high, of

thicknesses indicated.

3. Type: unless otherwise shown on the drawings, concrete masonry units shall be hollow blocks of a design approved by the Engineer.

C. Fireclay bricks: provide bricks made from fireclay containing a high percentage of silica and suitable for the conditions of proposed use.

1. Obtain bricks from a manufacturer approved by the Engineer.
2. Obtain fireclay cement from the brick manufacturer.

MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I; BS 12.

B. Hydrated Lime: ASTM C 207, Types S; BS 890 class B.

C. Sand Aggregate: ASTM C 144; BS 1200 Table I, washed and mechanically graded.

D. Water: Clean and potable.

JOINT REINFORCEMENT AND TIES

A. Materials: Comply with requirements indicated below and obtain approval of the Engineer for each type of joint reinforcement and tie for size and other characteristics.

B. Wall Ties: galvanized steel ties conforming to BS. 1243.

C. Joint Reinforcement: Provide approved galvanized steel welded-wire units prefabricated with deformed continuous side rods and plain cross rods into straight lengths of not less than 3000 mm, with prefabricated corner and tee units, and complying with requirements indicated below:

1. Width: Fabricate joint reinforcement in units with widths of approximately 50 mm less than nominal width of walls and partitions as required to provide mortar coverage of not less than 16 mm on joint faces exposed to exterior and 12 mm elsewhere.
2. Wire Size: 4 mm diameter.
3. Type: Ladder design, single side rods with perpendicular cross rods spaced not more than 400mm overall centres.

MISCELLANEOUS MASONRY ACCESSORIES

A. Reinforcing Bars: Deformed steel, ASTM A 615, Grade 60 ; BS. 4449, 4461.

B. Premolded Control Joint Strips: Material designed to fit standard sash block and to maintain lateral stability in masonry wall; sizes and configuration as required and approved.

C. Bond Breaker Strips: Asphalt-saturated organic roofing felt.

D. Weepholes: Medium density polyethylene plastic tubing, outside diameter and length as required.

MORTAR AND GROUT MIXES

A. General: Do not add admixtures including coloring pigments, air-entraining agents, accelerators, retarders, water repellent agents, anti-freeze compounds or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.

B. Mixing: Combine and thoroughly mix cementitious, water and aggregates in a mechanical batch mixer; comply with ASTM or BS standards for mixing time and water content.

C. Mortar for Unit Masonry: Comply with ASTM or BS; Proportion mixes , for types of mortar required, unless otherwise indicated.

1. Limit cementitious materials in mortar to Portland cement-lime.

D. Grout for Unit Masonry: Comply with ASTM or BS for grout used in construction of reinforced and non-reinforced unit masonry. Use grout of consistency indicated or if not otherwise indicated, of consistency (fine or coarse) at time of placement which will completely fill all spaces intended to receive grout.

PART 3 - EXECUTION

INSTALLATION, GENERAL

A. Do not wet concrete masonry units.

B. Cleaning Reinforcing: Remove ice and other coatings from reinforcing before placing.

C. Thickness: Build masonry construction to the full thickness shown. Build single-wythe walls (if any) to the actual thickness of the masonry units, using units of nominal thickness indicated.

D. Build chases and recesses as shown or required for the work of other trades. Provide not less than 200 mm of masonry between chase or recess and jamb of openings, and between adjacent chases and recesses.

E. Leave openings for equipment to be installed before completion of masonry work. After installation of equipment, complete masonry work to match work immediately adjacent to the opening.

F. Cut masonry units using motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide continuous pattern and to fit adjoining work. Use full-size units without cutting where possible.

1. Use dry cutting saws to cut concrete masonry units.

LAYING MASONRY WALLS

A. Layout walls in advance for accurate spacing of surface bond patterns with uniform joint widths and to accurately locate openings, movement-type joints, returns and offsets. Avoid the use of less-than-half-size units at corners, jambs and wherever possible at other locations.

B. Lay-up walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other work.

C. Pattern Bond: Lay exposed masonry in the bond pattern shown or, if not shown, lay in running bond with vertical joint in each course centered on units in courses above and below. Lay concealed masonry with all units in a Wythe in running bond or bonded by lapping not less than 50 mm. Bond an interlock each course of each Wythe at corners. Do not use units with less that nominal 100 mm horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Rack back 1/2-unit length in each course; do not tooth. Clean exposed surfaces of set masonry, wet units lightly (if required) and remove loose masonry units and mortar prior to laying fresh masonry.

E. Built-in Work: As the work progresses, build-in items specified under this and other sections of these specifications. Fill in solidly with masonry around built-in items.

1. Fill space between hollow metal frames and masonry solidly with mortar, unless otherwise indicated.

2. Where built-in items are to be embedded in cores of hollow, concrete masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core.

3. Fill cores in hollow concrete masonry units with grout 3 courses under bearing plates, beams, lintels, posts and similar items, unless otherwise indicated.

MORTAR BEDDING AND JOINTING

A. Lay hollow concrete masonry units with full mortar coverage on horizontal and vertical face shells. Bed webs in mortar in starting course on footings and in all courses of piers, columns and pilasters, and where adjacent to cells or cavities to be reinforced or filled with concrete or grout. For starting course on footings where cells are not grouted, spread out full mortar bed including areas under cells.

B. Maintain joint widths shown, except for minor variations required to maintain bond alignment. If not shown, lay walls with 9 mm joints.

C. Cut joints flush for masonry walls, which are to be concealed or to be covered by other materials, unless otherwise indicated.

D. Rake out joints on faces of blockwork, which are to be rendered or plastered, to a depth of 10 mm, as the work proceeds.

E. Tool exposed joints slightly concave using a jointer larger than joint thickness, unless otherwise indicated, as the work proceeds.

F. Remove masonry units disturbed after lying; clean and reset in fresh mortar. Do not pound corners or jambs to shift adjacent stretcher units, which have been set in position. If adjustments are required, remove units, clean off mortar and reset in fresh mortar.

G. Collar Joints: After each course is laid, fill the vertical longitudinal joint between Wythes solidly and with mortar for the following masonry work:

1. Non-loadbearing interior walls or partitions where metal ties or horizontal reinforcing are required for structural bonding and nominal thickness of wall or partition is required to meet code requirements for height-to-thickness ratio.

ANCHORING MASONRY WORK

A. General: Provide anchor devices of types indicated and required.

B. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:

1. Anchor masonry to structural concrete members with metal ties (cast into concrete) embedded in masonry joints.

2. Space ties as required, but not more than 600 mm vertically and 1000mm horizontally.

LINTELS

A. Install steel lintels where indicated.

B. Provide cast in place reinforced concrete lintels, minimum 200mm deep x full width of wall. Temporarily support lintels.

C. Provide minimum lintel bearing of 200 mm at each jamb, unless otherwise indicated.

4.2 EXTERIOR STONEWORK

PART 1 - GENERAL

SUMMARY

A. Extent of stonework is indicated on Drawings.

B. Types of stonework in this section include:

1. Exterior stone veneers and facings.

C. Interior stone facing and flooring is specified in the Finishes section of the Specification.

SYSTEM DESCRIPTION

A. General: Fabricate and install stonework to withstand normal loads from wind, gravity, movement of building structure, and thermally induced movement, as well as to resist deterioration under conditions of normal use including exposure to weather, without failure.

B. Provide stonework, which is designed, fabricated and installed, based on the safety factors applied to minimum physical properties of the different stones indicated.

C. Provide hand-set stone anchoring system which results in attachments developing the capability to sustain the following forces generated by the supported element (individual member or assembly) acting separately, based on the yield strength of the material:

1. A total force of 4 times the dead weight of the element supported, applied vertically downward through the element's centre of gravity, combined with loads caused by thermal movements.

2. A total force of 3 times the dead weight of the element applied horizontally outwards through the centre of gravity of the element, combined with loads caused by thermal movements.

QUALITY ASSURANCE

A. Single Source Responsibility for Stone : obtain each colour, grade, finish, type and variety of stone from a single quarry with resources to provide materials of consistent quality in appearance and physical properties, including the capacity to cut and finish material without delaying the progress of the work.

PART 2 - PRODUCTS

MATERIALS, GENERAL

A. Comply with relevant standards and other requirements indicated, as applicable to each type of material required.

B. Provide matched blocks from a single quarry for each type similar to existing or where applicable, variety, colour and quality of stone required. Extract blocks from a single bed of quarry stratum, unless stones from randomly selected blocks are acceptable to Engineer for aesthetic effect.

C. Provide stones, which are free from vents, cracks, fissures, discoloration or other surface defects, which may adversely effect strength or appearance.

STONE FABRICATIONS

A. General: fabricate stonework in sizes and shapes required to comply with requirements indicated, including details on Drawings and final shop drawings.

B. Cut and drill sinkages and holes in stones for anchors, fasteners, supports and lifting devices as indicated or needed to set stonework securely in place; shape beds to fit supports.

C. Cut stones to produce pieces of thickness, size and shape indicated or required and within fabrication tolerances recommended by applicable codes or standards or, if none, stone source, for faces, edges, beds, and backs.

1. Quirk-miter corners, unless otherwise indicated; provide for cramp anchorage in top and bottom bed joints of corner pieces.

D. Finish exposed faces and edges of stones to comply with requirements indicated for finish under each type and application of stone required and to match approved samples.

PART 3 - EXECUTION

EXAMINATION

A. Examine surfaces to receive stonework and conditions under which stonework will be installed. Do not proceed with installation until surfaces and conditions comply with requirements indicated in specifications or elsewhere for execution of other work, which affects stonework.

SETTING STONE, GENERAL

A. Execute stonework by skilled masons, and stone fitters at the site to do necessary field cutting, as stones are set.

1. Use power saws to cut stones; for exposed edges, produce edges, which are cut straight and true.

B. Contiguous Work: Provide chases, reveals, reglets, openings and other spaces as required for accommodating contiguous work. Close-up openings in stonework after work is in place with stonework which matches that already set.

C. Set stones to comply with requirements indicated on drawings and final shop drawings. Install anchors, supports, fasteners and other attachments indicated or necessary to secure stonework on place. Shim and adjust anchors, supports and accessories to set stones accurately in locations indicated with uniform joints of

widths indicated and with edges and faces aligned according to established relationship and indicated tolerances.

D. Construction Tolerances: set stones to comply with the following tolerances:

1. Variation from Plumb: For lines and surfaces of columns, walls and arises, do not exceed 6mm in 3m, 10mm in a story height or 6m maximum, nor 15mm in 12m or more. For external corners, expansion joints and other conspicuous lines, do not exceed 6mm in any story or 6m maximum, nor 15mm in 12m or more.

2. Variation from Level: For grades indicated for exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines, do not exceed 15mm in any bay or 6m maximum, nor 20mm in 12m or more.

3. Variation of Linear Building Line: For position shown in plan and related portion of columns, walls and partitions, do not exceed 15mm in any bay or 500mm maximum, nor 20mm in 12m or more.

4. Variation in Cross-Sectional Dimensions: For columns and thickness of walls from dimensions indicated, do not exceed minus 6mm nor plus 15mm.

ADJUSTING AND CLEANING

A. Remove and replace stonework of the following description:
1. Broken, chipped, stained or otherwise damaged stones.
2. Defective joints.
3. Stones and joints not matching approved samples.
4. Stonework not complying with other requirements indicated.

B. Replace in manner which results in stonework matching approved samples, complying with other requirements and showing no evidence of replacement.

C. Clean stonework not less than 6 days after completion of work, using water and stiff bristle fiber brushes. do not use wire brushes, acid-type cleaning agents, cleaning compounds with caustic or harsh fillers, or other materials or methods which could damage stone.

PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Engineer, which ensures stonework being without damage or deterioration at time of final handing over.

CHAPTER FIVE
METAL WORKS

5.1 METAL FABRICATIONS

PART 1 - GENERAL

SUMMARY

A. Definition: Metal fabrications includes components and assemblies from ferrous and non-ferrous metal shapes, plates, bars, strips, tubes, pipes and castings which are not a part of structural steel or other metal systems specified elsewhere.

B. Extent of metal fabrications is indicated on drawings, and includes but is not necessarily limited to the following:

1. Ladders
2. Floor drain covers
3. Water tank access covers
4. Steel gates
5. Aluminum handrails and railing systems
6. Miscellaneous steel pipe railings
7. Miscellaneous checker plate fabrications
8. Miscellaneous supports for overhead doors and the like.

PROJECT CONDITIONS

A. Field Measurements: Check actual locations of walls and other construction to which metal fabrications must fit, by accurate field measurements before fabrications; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of Work.

1. Where field measurements cannot be made without delaying the work, guarantee dimensions and proceed with fabrication of products without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to guaranteed dimensions. Allow for trimming and fitting.

PART 2 - PRODUCTS

MATERIALS

A. Ferrous Metals

1. Metal Surfaces, General: For fabrication of miscellaneous metal work which will be exposed to view, use only materials which are smooth and free of surface blemishes and including pitting, seam marks, roller marks, rolled trade names and roughness.

2. Steel Plates, Shapes and Bars: ASTM A 36 or BS 1449.

3. Rolled Steel floor plates: ASTM A 786.

4. Steel Bar Grating: ASTM A 569 or ASTM A 36.

5. Steel Tubing: Cold formed, ASTM A 500; or hot-rolled, ASTM A 501, BS 4848, or BS 2994.

6. Structural Steel Sheet: Hot-rolled, ASTM A 570; or cold-rolled ASTM A 611, of grade required for design loading.

7. Galvanized Structural Steel Sheet: ASTM A 446, of grade required for design loading. Coating designation as indicated, or if not indicated, G90.

8. Steel Pipe: ASTM A 53 or BS 4848. Type and grade as selected by fabricator and as required for design loading; black finish unless galvanizing is indicated; standard weight (schedule 40), unless otherwise indicated.

9. Grey Iron Castings: ASTM A 48, Class 30, or BS 1452.

10. Malleable Iron Castings: ASTM A 47, grade as selected by fabricator.

11. Brackets, Flanges and Anchors: Cast or formed metal of the same type material and finish as supported rails, unless otherwise indicated.
12. Concrete Inserts: Threaded or wedge type, galvanized ferrous castings, either malleable iron, ASTM A 47, or cast steel, ASTM A 27. Provide bolts, washers and shims as required, hot-dip galvanized, ASTM A 153.

B. Aluminum
1. All aluminum works should be as manufactured by Sidem Type 2000

C. Grout
1. Non-Shrink Non-Metallic Grout: Pre-mixed, factory-packaged, non-staining, non-corrosive, non-gaseous grout. Provide grout specifically recommended by manufacturer for interior and exterior applications of type specified and required.

D. Fasteners
1. General: Provide stainless steel fasteners for exterior use or where built into exterior walls. Select fasteners for the type, grade and class required.

2. Bolts and Nuts: Regular-hexagon head type.

Lag Bolts: Square head type.

Machine Screws: Cadmium plated steel.

Wood Screws: Flat head carbon steel.

Plain Washers: Round, carbon steel.

Anchorage Devices: Drilled in expansion anchor bolts.

Toggle Bolts: Tumble-wing type, class and style as required.

Lock Washers: Helical spring type carbon steel.

E. Paint
1. Shop Primer for Ferrous Metal: Manufacturer's or fabricator's standard, fast-curing, lead-free, "Epoxy" primer; selected for good resistance to aggressive atmospheric corrosion, for compatibility with finish paint systems indicated and for capability to provide a sound foundation for field applied topcoats despite prolonged exposure.

2. Galvanizing Repair Paint: High zinc dust content paint for regalvanizing welds in galvanized steel.

3. Bituminous Paint: Cold applied asphaltic mastic.

4. Zinc Chromate Primer.

F. STAINLESS STEEL

Where stainless steel is specified it shall be what is known to the trade as Austentic 18-8, type 316, with a content of from 17% to 19% chrome, 7% to 9% nickel and a maximum, carbon content of 0.11%.

Stainless steel shall be free from scale and all surfaces shall be polished to a No.4 commercial finish where specified.

PART 3 - EXECUTION

PREPARATION

A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, such as concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

INSTALLATION

A. General:

1. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; including, threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws and other connectors as required.

2. Cutting, Fitting and Placement: Perform cutting drilling and fitting required for installation of miscellaneous metal fabrications. Set work accurately in location, alignment and elevation, plus, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items, which are to be built into concrete masonry or similar construction.

3. Fit exposed connections accurately together to form tight hairline joints. Weld connections, which are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind exposed joints smooth and touch-up shop paint coat. Do not weld, cut or abrade the surfaces of exterior units, which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.

4. Field welding: Comply with relevant codes for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.

5. Corrosion Protection: Coat concealed surfaces of Aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint or zinc chromate primer.

B. Railings and Handrails:

1. Adjust railing prior to anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated, or if not indicated, as required by design loadings. Plumb posts in each direction. Secure posts and railing ends to building construction as indicated on drawings and as required.

    a. Anchor posts in concrete by means of pipe sleeves preset and anchored into concrete. After posts have been inserted into sleeves, fill annular space between post and sleeve solid with non-shrink, non-metallic grout, mixed, placed and sealed to comply with grout manufacturer's

directions.

2. Secure handrails to wall with wall brackets and end fittings. Provide bracket with not less than 37mm clearance from inside face of handrail and finished wall surface. Locate brackets as indicated, or if not indicated, at spacing required for design loading. Secure wall brackets and wall return fittings to building construction as required.

ADJUST AND CLEAN

1. Touch-Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

2. For galvanized surfaces: Clean field welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780, or BS 729.

5.1.1 NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

SUMMARY

Section Includes:

Non-load-bearing steel framing systems for interior gypsum board assemblies.
Suspension systems for interior gypsum ceilings and soffits.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: Provide materials and construction identical to those tested according to ASTM E 119.

B. STC-Rated Assemblies: Provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413.

Recycled Content of Steel Products: Provide products with average recycled content of steel products such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than [**25**] percent.

2.2 FRAMING SYSTEMS

A. Steel Studs and Runners: ASTM C 645.[Use either steel studs and runners or dimpled steel studs and runners of equivalent minimum base-metal thickness.]

Minimum Base-Metal Thickness: [**As indicated on Drawings**]

Depth: [**As indicated on Drawings**].

B. Slip-Type Head Joints: Where indicated, provide[one of] the following in thickness not less than indicated for studs and in width to accommodate depth of studs:
   1. Single Long-Leg Runner System: ASTM C 645 top runner with (51-mm) deep flanges, installed with studs friction fit into top runner and with continuous bridging located within (305 mm) of the top of studs to provide lateral bracing.
   2. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch- (51-mm-) deep flanges and fastened to studs, and outer runner sized to friction fit inside runner.
   3. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes due to deflection of structure above.

      Products: Subject to compliance with requirements, [**available products that may be incorporated into the Work**]:

C. Firestop Tracks: Manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

   1. Products: Subject to compliance with requirements, [**available products that may be incorporated into the Work**]:

D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

   1. Minimum Base-Metal Thickness: [**As indicated on Drawings**].

E. Cold-Rolled Channel Bridging: Steel, (1.34-mm) minimum base-metal thickness, with minimum (13-mm-) wide flanges.

   1. Depth: [**As indicated on Drawings**].

Clip Angle: Not less than (38 by 38 mm), (1.72-mm-) thick, galvanized steel.

F. Hat-Shaped, Rigid Furring Channels: ASTM C 645.

   1. Minimum Base-Metal Thickness: [**As indicated on Drawings**] .

Depth: [**As indicated on Drawings**] .

G. Resilient Furring Channels: (13-mm-) deep, steel sheet members designed to reduce sound transmission.

   1. Configuration: [**hat shaped**].

H. Cold-Rolled Furring Channels: (1.34-mm) uncoated-steel thickness, with minimum (13-mm-) wide flanges.

   1. Depth: [**As indicated on Drawings**].

Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum uncoated-steel thickness of (0.8 mm).

Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, (1.59-mm-) diameter wire, or double strand of (1.21-mm-) diameter wire.

I. Z-Shaped Furring: With slotted or nonslotted web, face flange of [(31.8 mm)], wall attachment flange of (22 mm), minimum uncoated-metal thickness of (0.45 mm), and depth required to fit insulation thickness indicated.

2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire.

B. Hanger Attachments to Concrete:

Anchors: Capable of sustaining a load equal to [**5**] times that imposed as determined by ASTM E 488.

Type: [**Postinstalled, expansion anchor**].

Powder-Actuated Fasteners: Capable of sustaining, a load equal to [**10**] times that imposed as determined by ASTM E 1190.

C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch (4.12 mm) in diameter.

D. Flat Hangers: Steel sheet, [in size indicated on Drawings].

E. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of (1.34 mm) and minimum (13-mm) wide flanges.

1. Depth: [**As indicated on Drawings**].

F. Furring Channels (Furring Members):

1. Cold-Rolled Channels: (1.34-mm) uncoated-steel thickness, with minimum (13-mm-) wide flanges, (19 mm) deep.
2. Steel Studs and Runners: ASTM C 645.[**Use either steel studs and runners or dimpled steel studs and runners of equivalent minimum base-metal thickness.**]

a. Minimum Base-Metal Thickness: [**As indicated on Drawings**]
b. Depth: [**As indicated on Drawings**].

3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, (22 mm) deep.

a. Minimum Base-Metal Thickness: [**As indicated on Drawings**].

4. Resilient Furring Channels: (13-mm-) deep members designed to reduce sound transmission.

a. Configuration: [**hat shaped**].

2.4 AUXILIARY MATERIALS

A. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide [foam gasket].

PART 3 – EXECUTION

3.6 INSTALLATION, GENERAL

A. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

B. Install bracing at terminations in assemblies.

C. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.7 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install

isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.

2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

   a. Install two studs at each jamb unless otherwise indicated.
   b. Install cripple studs at head adjacent to each jamb stud, with a minimum (13-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
   c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.

   a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
6. Curved Partitions:

   a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
   b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs (150 mm) o.c.

E. Direct Furring:

1. Screw to wood framing.
2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced (610 mm) o.c.

F. Z-Furring Members:

1. Erect insulation vertically and hold in place with Z-furring members spaced [**600 mm**] o.c.

2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced (610 mm) o.c.

3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than (305 mm) from corner and cut insulation to fit.

G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than (3 mm) from the plane formed by faces of adjacent framing.

3.8 INSTALLING SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required

by referenced installation standards for assembly types.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.

   a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, counters playing, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
3. Do not attach hangers to steel roof deck.
4. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
5. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
6. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Seismic Bracing: Sway-brace suspension systems [**with hangers used for support**].

F. Installation Tolerances: Install suspension systems that are level to within [(3 mm in 3.6 m)] measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

5.1.2 METAL DOOR AND FRAMES

PART 1 - GENERAL

8.1.1 DESCRIPTION

A. General

1. Furnish all labor, materials, tools, equipment, and services for metal doors and frame, in accord with provisions of Contract Documents.
2. Completely coordinate with work of other trades.
3. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.
4. See Division 1 for General Requirements.

B. Related work specified elsewhere:

1. Finish hardware: Section 8.5.
2. Wood doors: Section 8.2.
3. Glass and glazing: Section 8.4.

8.1.1.2 Submittals

A. Product Data:
1. Manufacturer's technical information including specifications and catalog cuts for all products specified herein.

B. Shop Drawings:
   1. Show details of each frame type and elevations of each door type. Show conditions at openings and details of construction.
   2. Show gages, location of reinforcements, anchorage and accessory items.
   3. Submit schedule of doors and frames. Use same scheduling system as that shown in the Door Schedule.

PART 2 - PRODUCTS

8.1.2 MATERIALS - GENERAL

A. Steel sheet and strip: Commercial quality carbon steel, ASTM A568.

B. Galvanized steel sheets: ASTM A525, G90 coating, phosphatized.

C. Supports and anchors: Not less than 1.5 mm (16 ga) sheet steel. Galvanize items to be built into exterior walls after fabrication, ASTM A153, Class B.

D. Inserts, bolts and fasteners: Manufacturer's standard units. Galvanize items to be built into exterior walls ASTM A153, Class C or D as applicable.

E. Primer: Suitable for Galvanized metal sheets enamel or paint, air-drying or baked, suitable as base for specified finish paints**.**

F. Galvanized repair paint: Mil. Spec. DOD-P-21035.

G. Lead sheet: ASTM B29, free from imperfection affecting performance, thickness as indicated.

8.1.2.1 Doors and Frames

A. Doors, Timber or Melamine.

B. Vision panels:
   1. Fixed, integral stops on exterior face, screwless snap-in stops or stops secured with countersunk Phillips head machine screws on interior face.
   2. Glass: Section 8.4.

C. Frames, Timber or Melamine, types as indicated.
   1. Split-type frames are not acceptable.
   2. Conceal all fastenings.
   3. All joints: Tightly butted and fully welded.
   4. All frames should be painted from the back & bottom 15 cm with asphalt.

8.1.2.2 FABRICATION

A. General:
   1. Fabricate rigid, neat in appearance and free from defects.
   2. Form to indicated sizes and profiles.
   3. Fit and assemble in shop, where practical.
   4. Mark work that cannot be fully assembled in shop, to assure proper assembly at site.

B. Prepare for finish hardware, in accord with hardware schedule, templates provided by hardware supplier, and ANSI A115 series "Specifications for Door and Frame Preparation ".
   1. Locate finish hardware in accord with SDI 100.

2. Locate patient latches in accord with manufacturer's recommendations.

C. Clean off mill scale and foreign materials, touch-up damaged steel and galvanized surfaces.

D. Shop prime.

PART 3 - EXECUTION

8.1.3.1 INSPECTION

A. Examine structure, substrates, and conditions under which work in to be installed for conditions detrimental to correct and timely completion.

B. Installation constitutes acceptance of responsibility for performance.

8.1.3.2 INSTALLATION

A. Place frames prior to construction of enclosing walls and ceilings.

B. Separate structural lintels are to be installed over all doorframes in masonry. Do not use doorframes as lintels to carry masonry.

C. Plumb, align, and brace securely until permanently anchored.

D. After completion of walls, remove temporary braces and spreaders.

E. Install minimum of 3 anchors of type appropriate to wall construction per jamb. Minimum acceptable anchors: 1.5 mm (16 ga), 25 mm (1 IN) wide corrugated steel.

F. Provide removable spreaders at bottom of frame.

G. Coordinate building-in of anchors and frame grouting with other trades.

H. Grout all frames.

I. Leave work complete and in proper operating condition.

G. Remove defective work and provide new acceptable products.

CHAPTER SIX
WOOD WORKS

6.1 JOINERY

PART 1 - GENERAL

SUMMARY

A. Types of joinery and architectural woodwork included in this Section include the following:

1. Wood casework.
2. Plastic laminate clad casework.
3. Countertops, including stonework counter tops.
4. Hardware, ironmongery, accessories and miscellaneous trim incorporated into joinery in accordance with Drawings.

B. "Rough Carpentry" for grounds, blocking, framing, furring, and other carpentry work that is not exposed to view is specified elsewhere.

C. Wood Doors are specified elsewhere.

QUALITY ASSURANCE

A. Manufacturer Qualifications: Firm experienced in successfully producing joinery and architectural woodwork similar to that indicated for this Project, with sufficient production capacity to produce required units without causing delay in the Work.

B. AWI Quality Standard: Comply with applicable requirements of "Architectural Woodwork Quality Standard" published by the Architectural Woodwork Institute (AWI) except as otherwise indicated.

C. Hardware Coordination: Distribute copies of approved schedule for cabinet hardware to manufacturer of joinery and architectural woodwork; coordinate cabinet shop drawings and fabrication with hardware requirements.

D. Except for stonework, proprietary names used to designate colors or materials are not intended to imply that products named are required or to exclude products of other manufacturers.

PART 2 - PRODUCTS

MATERIALS

A. General: Provide materials of premier quality grades that comply with requirements of the relevant woodworking standard for each type of woodwork and, where the following products are part of woodwork, with requirements of the referenced product standards, that apply to product characteristics indicated:

1. Hardboard.

2. Plastic Laminate Facing: BS 3794, Class 1, 1.5 mm thick.

3. Plywood: BS 1455 ; WBP bonding; Grade 1 where polished / varnished.

4. Blockboard (Latte): BS 3444 ; WBP bonding.

5. Face Veneers: Hard, durable and capable being finished to a smooth surface; free from knots, holes

splits, stains, filling or any other defects.

6. Adhesives for Face Veneers: BS 1203.

WOOD TYPES

A. General: Provide first quality premier grade wood types where indicated on Drawings and as specified herein.

1. Softwood: Douglas Fir, Longleaf Pine, European Redwood, or other equal approved.

2. Pine: (where shown on Drawings) South American Parana Pine.

3. Hardwoods and Veneers:

a. Generally: Canadian Yellow Birch, Meranti, Zan, or other equal approved.
b. Teak: Burmese teak.
c. Mahogany: Honduran mahogany.

PART 3 - EXECUTION

INSTALLATION GENERALLY

A. Quality Standard: Install woodwork to meet or exceed AWI Section 1700 for same grade specified in Part 2 of this section for type of woodwork involved.

B. Install woodwork plumb, level, true, and straight with no distortions. Shim as required with concealed shims. Install to a tolerance of 6.25 mm in 2400 mm for plumb and level (including tops) and with no variations in flushness of adjoining surfaces.

C. Scribe and cut woodwork to fit adjoining work and refinish cut surfaces or repair damaged finish at cuts.

D. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure to grounds, stripping and blocking with countersunk, concealed fasteners and blind nailing as required for a complete installation. Except where prefinished matching fastener heads are required, use fine finishing nails for exposed nailing, countersunk and filled flush with woodwork and matching final finish where transparent finish is indicated.

E. Casework and Cabinets: Install without distortion so that doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete the installation of hardware and accessory items as indicated and required. Maintain veneer sequence matching (if any) of cabinets with transparent finish.

F. Tops: Anchor securely to base units and other support systems as indicated.

G. Complete the finishing work specified in this section to whatever extent not completed at shop or before installation of woodwork.

ADJUSTMENT AND CLEANING

A. Repair damaged and defective woodwork where possible to eliminate defects functionally and visually; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.

B. Clean, lubricate, and adjust hardware.

C. Clean woodwork on exposed and semi exposed surfaces. Touch up factory applied finishes to restore damaged or soiled areas.

PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to the Engineer that ensures that woodwork is undamaged at time of Taking-Over.

6.1.1 CABINETWORK

6.1.1.1 GENERAL

A. Description:

1. Furnish all labor, materials, tools, equipment, and services necessary for architectural cabinetwork, in accord with provisions of Contract Documents.
2. Completely coordinate with work of other trades.
3. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

B. See drawings for types of countertops required.

C. Submittals:

1. Shop drawings:
   a) Complete details of construction and elevations of all cabinets.

2. Product data:
   b) Wall cabinet load test reports.

3. Samples:
   c) Each finish for pattern, finish and color selection.

D Conditions:

1. Verify dimensions at site.

2. Verify locations of items related to cabinetwork but specified in other sections.

3. If necessary to vary from arrangement indicated because of structural, mechanical, electrical or other considerations, make such variations only after approval of Architect.

6.1.1.2 PRODUCTS

A. General

A.1 Cabinetwork: Custom, shop- or factory-built casework, complete with all hardware, accessories, countertops and bases, in sizes and configurations indicated.

1. Style: Flush overlay, with square cornered doors and drawer fronts overlapping case front with minimum reveal.

B. Hardware

B.1 Hardware for hinged doors:

1. Hinges: Institutional (hospital tip), 5 knuckle, wrap-around type (screwed to back of door and side of divider/end), with barrel only projecting beyond face of cabinet.
   a. Not less than 62 mm (2-1/2 IN) long.
   b. Minimum 3 screws each leaf.
   c. For doors up to 1200 mm (48 IN) high: 2 hinges.
   d. For doors over 1200 m (48 IN) high: 3 hinges.
   e. Finish: Dull chrome.

2. Pull: Wire, 7.9 mm (5/16 IN) diameter x 33.3 mm (1 5/16 IN) projection x 100 m (4 IN) centers, satin chrome finish.

3. Catch: Magnetic, adjustable, 2.7 to 3.2 KG (6-7 LB) pull, provide 2 on each door over 0.37 SM (4 SF), provide 1 on each door 0.37 SM (4 SF) and smaller.

B.2 Hardware for drawers:

1. Slides: Zinc-plated cold-rolled steel, side slides, 45 KG (100 LB) capacity, nylon wheels/rollers, stainless steel ball bearings, positive closing and pull-out stops, drawer removable without use of tools, file drawers: Full extension. Required clearance 19 mm (3/4 IN).

2. Pull: Wire, 7.9 mm (5/16 IN) diameter x 33.3 mm (1 5/16 IN) projection x 100 mm (4 IN) centers, satin chrome finish. Provide 2 on drawers over 457 mm (18 IN) wide.

3. For file drawers: Label holder and file hanger frame.

B.3 Shelf supports (drilled hole type):

1. Holes drilled at 25 to 50 mm (1 to 2 IN) OC.

2. Shelf clips: Nylon, ABS plastic, or steel, designed to engage securely in holes.

B.4 Shelf supports (recessed standard type):

1. Standards: Aluminum or zinc-coated or plated steel, slotted at 25 to 50 mm (1 to 2 IN) OC, for recessed installation.

2. Shelf clips: Plated or zinc-coated steel, designed to engage securely in slots.

B.5 Clothes rod:

Chrome plate or stainless steel tube, 25 mm (1 IN) diameter minimum, manufacturer's standard end bracket supports.

B.6 Coat hooks:

Stainless steel or satin aluminum, single, double or ceiling style as indicated.

B.7 Grilles: Aluminum, satin finish.

1. Type 1: 70 percent free area, 2.5 mm (0.1 IN) WG maximum, total static pressure loss.

2. Type 2: Opposed blade damper, 70 percent free area, maximum neck velocity 914.4 M/Min (3000 FPM), 2.5 mm (0.1 IN) WG maximum total static pressure loss.

C. Fabrication-Case Components-Plastic Faced

C.1 Case body members (except backs not exposed): 18 mm (3/4 IN) minimum thick plywood.

1. Base unit top: Use either full sub-top or web frame.
2. Web frames: Lumber.
3. Provide drawer lock rails at all drawers.
4. Provide backs on all cabinets.

C.2 Unexposed case back: 6 mm (1/4 IN) minimum thick hardboard or plywood.

C.3 Shelves: 18 mm (3/4 IN) minimum thick plywood, 25 mm (1 IN) thick over 91 mm (36 IN) between supports.

C.4 Doors: Plywood.

1. Up to 650 mm (26 IN) wide or 1220 mm (48 IN) high: 18 mm (3/4 IN) thick.
2. Up to 900 mm (36 IN) wide or 1680 mm (66 IN) high: 30 mm (1 1/4 IN) thick.
3. Over 900 mm (36 IN) wide or 1680 mm (66 IN) high: 35 mm (1 3/8 IN) thick, solid-core.

C.5 Drawers:

1. Fronts: 18 mm (3/4 IN) thick Plywood.
2. Sub-front (if used) sides and backs: 12 mm (1/2 IN) thick hardwood.
3. Bottom: 6 mm (1/4 IN) thick, minimum, hardboard, over 45 mm (18 IN) wide provide intermediate reinforcing rails.

C.6 Case base: Separate or integral.

C.7 Small compartment dividers and dust panels: 6 mm (1/4 IN) thick hardboard.

C.8 Filler panels and scribe pieces: Plywood, provide as required to fit standard size units to space.

C.9 Plastic laminate countertops: 18 mm (3/4 IN) thick Plywood, built up to 31 mm (1-1/4 IN) at all edges. Backsplash 102 mm high.

C.10 Finishes:

1. All exposed surfaces: Plastic laminat (1.5mm Thick).
2. All semi-exposed surfaces not covered with plastic laminate backer sheet (except hardwood): Plastic overlay. (1.5mm Thick)
3. Edges of doors, drawer fronts and case body members: Hardwood strips as shown on Drawings.

C.11 Finishing hardwood:

1. Set all nails.
2. Fill holes.
3. Sand smooth.
4. Apply stain.
5. Sand after stain is dry.
6. Apply varnish in 3 coats.
7. Sand between coats.

6.2 HIGH PRESSURE LAMINATE (HPL)

6.2.1 GENERAL

Constructed from layers of high quality kraft paper, reinforced by thermosetting resins under high pressure and temperature with one decorative surface. The result is a hygienic 0.8 mm thick flexible sheet material.

HPL is bonded onto a high density coreboard to produce a strong finished panel. Panels can be post-formed to create a seamless, curved edge detail.

HPL is suitable for use in areas of high traffic and reasonably demanding conditions.

6.2.2 PANEL CUBICLES

A. SCOPE OF SECTION

This section deals with proprietary panel cubicles assembled on site from factory finished kits of parts including, panels, doors, privacy screens, framing, stiffening, connecting and fixing devices, door ironmongery, coat hooks, toilet roll holders, bench and other accessories.

B. PANEL CUBICLES GENERALLY

- Manufacturer: Refer to appendix A.
  - Product reference: To the Engineer's selection.
- Panels:
  - Height (overall): As indicated on the contract drawings.
  - Floor clearance: As indicated on the contract drawings.
  - Core material: High pressure solid compact laminate.
  - Thickness: 12 mm.
  - Facings: To the Engineer's selection from the manufacturer's standard range.
  - Colour/ Pattern/ Species: To the Engineer's selection from the manufacturer's standard range.
  - Edge treatment: Chamfered and finished without trim.
  - Wall support: Aluminum satin anodized pedestals/shoes on the floor and aluminum satin anodized angles on the walls.
- Pilasters:
  - Core material: High pressure solid compact laminate.
  - Thickness: 12 mm.
  - Facings: To the Engineer's selection from the manufacturer's standard range.
  - Colour/ Pattern/ Species: To the Engineer's selection from the manufacturer's standard range.
  - Edge treatment: Chamfered and finished without trim.

- Doors:
  - Height: As indicated on the contract drawings.
  - Core material: High pressure solid compact laminate.
  - Thickness: 12 mm.
  - Facings: To the Engineer's selection from the manufacturer's standard range.
  - Colour/ Pattern/ Species: To the Engineer's selection from the manufacturer's standard range.
  - Edge treatment: Chamfered and finished without trim.
  - Ironmongery: Aluminum satin anodized.
  - Colour: To the Engineer's selection from the manufacturer's standard range.
- Fittings:
  - Headrails: Aluminum satin anodized.
  - Pedestals/ Shoes: Aluminum satin anodized.
- Accessories: Aluminum Satin Anodized heavy duty.
- Other requirements: All accessories to be of bacteria resistant Aluminum satin.

C. SAMPLES

- General: Before placing orders submit representative samples of the following:
  - Panel material and complete colour chart.
  - All ironmongery/ accessories.
- Delivered materials/ products: To match samples.

D. CONTROL SAMPLES

- General: Complete samples as part of finished work and obtain approval of appearance before proceeding.
- Types: All items specified in this section and applicable to the project.
  - Locations: As agreed with the Engineer.

E. INSTALLATION

- Programming: Do not install cubicles or duct/ wall panels before building is weathertight, wet trades have finished their work, wall and floor finishes are complete, and the building is well dried out.
- Accuracy: Set out to ensure frames and/ or panels and doors are plumb, level and accurately aligned.
- Modifications: Do not cut, plane or sand prefinished components except where shown on drawings.
- Fixing: Secure components using methods and fasteners recommended by the cubicle/ panel manufacturer. Prevent pulling away, bowing or other distortions to frames, panels and doors.
- Moisture and thermal movement: Make adequate allowance for future movement.

6.2.3 FABRICATION: ANODIZED ALUMINUM ACCESSORIES FOR TOILET PARTITIONS

Aluminum alloys are anodized to increase corrosion resistance and to allow dyeing (coloring), improved lubrication, or improved adhesion. However, anodizing does not increase the strength of the aluminum object. The anodic layer is non-conductive.

Aluminum alloy parts are anodized to greatly increase the thickness of this layer for corrosion resistance. The corrosion resistance of aluminum alloys is significant decreased by certain alloying elements or impurities: copper, iron, and silicon.

Although anodizing produces a very regular and uniform coating, microscopic fissures in the coating can lead to corrosion. To combat this, various techniques have been developed either to reduce the number of fissures or to insert more chemically stable compounds into the oxide, or both.

Anodized coatings have a much lower thermal conductivity and coefficient of linear expansion than aluminum.

CHAPTER SEVEN
THERMAL AND MOISTURE PROTECTION

7.1 ROOFING

7.1.1 ROOF WATERPROOFING

PART 1 - GENERAL

SUMMARY

A. Extent of each type of sheet waterproofing work is indicated on Drawings.

B. Types of sheet waterproofing specified in this Section include the following:
   1. Polyethylene sheet membrane.
   2. SBS modified bituminous sheet waterproofing membrane.

QUALITY ASSURANCE

A. Installer: Perform sheet waterproofing membrane installations by skilled operations or specialist contractor experienced and regularly engaged in the type of work.

PART 2 - PRODUCTS

MATERIALS

A. General: Provide sheet-waterproofing materials recognized to be generic to the types indicated and complying with required performances. Other similar materials certified in writing to be equal to or better than specified in every significant respect may be used if acceptable to Engineer.

POLYETHYLENE SHEET MEMBRANE

A. Chlorinated polyethylene formed into uniform flexible sheets, minimum 40 mil. thickness. Manufacturers offering products which may be incorporated in the work include but are not limited to:-
   1. MONYACO International: Lebanon.

B. Applications:
   1. Vapour Barrier: Under concrete slabs cast on ground or granular base at sub-grade elevations.

SBS MODIFIED BITUMINOUS SHEET WATERPROOFING MEMBRANE

A. Torch applied, self-adhering, sheet membrane of SBS (Styrene Butadiene Styrene) modified bitumen, reinforced with 160 - 200 g/m2 spun bonded, non woven, polyester, formed into uniform flexible sheets of thickness appropriate for application intended, but not less than 4 mm thick.

   1. Smooth surfaced.

B. Applications:

   1. Basement Tanking: Membrane waterproofing to underside / outside surfaces of underground concrete

slabs and walls enclosing basement structures.

2. Planter Linings: Membrane waterproofing to inside of concrete planters and the like, as indicated.

3. Unless otherwise specified or indicated provide protective coverings as recommended by the membrane manufacturer for application intended.

C. Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

1. Bitufa (Netherlands): 'Standard Plus', or approved equal.

MISCELLANEOUS MATERIALS

A. Adhesives: Provide types of adhesive compounds, tapes and the like as recommended by sheet manufacturer, for bonding to substrate, for waterproof sealing of seams in membrane, and for waterproof sealing of joints between membrane and flashings, adjoining surfaces and projections through membrane.

B. Primers: Provide type of concrete primer recommended by manufacturer of sheet material for applications required.

C. Coatings: Provide type of coating recommended by sheet manufacturer, for improvement of weathering resistance on exposed areas of membrane, including areas extended as flashing (if any). Provide black coating except as otherwise indicated.

D. Flashing Materials: Except as otherwise indicated, provide types of flexible sheet material for flashing as recommended by sheet manufacturer.

E. Protection Course: Unless otherwise indicated provide type recommended by sheet manufacturer, and acceptable to Engineer.

1. Available Manufacturers: Manufacturers offering products which may be incorporated into the work include but are not limited to:

a. Cartonal (Lebanon) or approved equal.

PART 3 - EXECUTION

PREPARATION

A. Examine substrates, areas and conditions under which sheet membranes will be installed, for compliance with manufacturers recommendations and installation requirements.

B. On concrete decks and walls, immediately before placement of waterproofing sheet, grind surface lightly with terrazzo grinder or similar device, to ensure removal of projections, which might penetrate sheet. Clean deck of loose material.

C. Apply primer to concrete (and masonry where applicable) surfaces at rate recommended by manufacturer of primary waterproofing materials. Prime only area, which will be covered by waterproof membrane in same working day; reprime areas not covered by membrane within 24 hours.

INSTALLATION

A. Comply with manufacturer's instructions for handling and installation of sheet membrane materials.

B. Coordinate installation of waterproofing materials and associated work to provide complete system complying with combined recommendations of manufacturers and installers involved in work. Schedule installation to minimize period of exposure of sheet materials.

C. Extend sheet and flashings as shown and to provide complete membrane over area indicated to be waterproofed. Seal to projections through membrane and seal seams. Bond to vertical surfaces and also, where shown or recommended by manufacturer, bond to horizontal surfaces.

D. Polyethylene Sheet Vapor Barrier: Lay, lap edges, seal joints with adhesive type, protect and repair vapor barrier sheet membrane according to manufacturer's instructions.

E. SBS Modified Bituminous Sheet Waterproofing: Install sheet waterproofing membrane system according to manufacturer’s instructions.

1. Roll out sheets to minimize wrinkles and bubbles; prime base, fix cants and accessories.

2. Torch apply to substrate; lap sides and ends and reinforce with multiple thickness at joints and angles; all in accordance with manufacturer's recommendations and instructions.

F. Install protection course of type indicated over completed membrane, complying with manufacturer's recommendations for both waterproofing sheet and protection course materials.

PERFORMANCE REQUIREMENTS

A. It is required that waterproof membranes are watertight and not deteriorate in excess of limitations published by manufacturer.

B. In-place Testing: Before completed membranes on horizontal surfaces are covered by protection course or other work, test for leaks with 50mm depth of water maintained for 24 hours. Repair any leaks revealed by examination of substructure and repeat test until no leakage is observed.

PROTECTION

A. Institute required procedures for protection of completed membrane during installation of work over membrane and throughout remainder of construction period. Do not allow traffic of any type on unprotected membrane.

7.1.2 SBS-MODIFIED BITUMINOUS MEMBRANE ROOFING

PART 1 - GENERAL

SUMMARY

A. This Section includes the following:

1. Single-ply, modified bituminous membrane roofing.
2. Polystyrene board roof insulation.
3. Precast concrete roof pavers.
4. Precast terrazzo roof pavers.
5. Aggregate ballast.

PERFORMANCE REQUIREMENTS

A. General: Install a watertight, modified bituminous membrane roofing and upstand base flashing system with compatible components that will not permit the passage of liquid water and will withstand wind loads, thermally induced movement, and exposure to weather without failure.

SUBMITTALS

A. Product Data: For each type of membrane and roofing product specified. Include data substantiating that materials comply with requirements.

B. Shop Drawings: Include plans, sections, thicknesses and details, including attachments to other work for the following:

1. Upstand base flashings, cants, and membrane terminations.

C. Samples: For verification and approval of the following products:

1. 300 x 300mm square of each modified bituminous membrane specified.
2. 300 x 300mm square of polystyrene board roof insulation.
3. Full-sized roof paver units, for each type, dimension, color and texture indicated or required.
4. 2.5kg of aggregate ballast in color and gradation indicated.

D. Installer Certificates: Signed by roofing membrane manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install specified roofing membrane and is eligible to receive the roofing manufacturer's standard warranty.

E. Manufacturer Certificates: Signed by roofing membrane manufacturer certifying that the roofing system complies with requirements specified in the "Performance Requirements" Article. Upon request, submit evidence of complying with requirements.

F. Warranty: Sample copy of roofing manufacturer's standard warranty stating obligations, remedies, limitations, and exclusions of warranty.

DELIVERY, STORAGE, AND HANDLING

A. Store roofing materials in a dry, well-ventilated, weather tight location to ensure no significant moisture pickup and maintain at a temperature exceeding roofing membrane manufacturer's written instructions. Store rolls of sheet materials on end on pallets or other raised surfaces. Do not double-stack rolls.

1. Handle and store roofing materials and place equipment in a manner to avoid significant or permanent damage to deck or structural supporting members.

B. Do not leave unused sheet materials on the roof overnight or when roofing work is not in progress unless protected from weather and moisture.

C. Deliver and store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing membrane manufacturer.

D. Protect roofing insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

PROJECT CONDITIONS

A. Weather Limitations: Proceed with roofing work only when existing and forecast weather conditions permit

roofing to be installed according to manufacturers' written instructions and warranty requirements.

WARRANTY

A. General Warranty: The warranties specified in this Article shall not deprive the Employer of other rights the Employer may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Roofing Manufacturer's Standard Warranty: Submit a written warranty, without monetary limitation, signed by roofing membrane manufacturer agreeing to promptly repair leaks in the roof membrane and upstand base flashings resulting from defects in materials or workmanship for the following warranty period:

1. Warranty Period: Five (5) years from date of completion of the whole of the Works.

PART 2 - PRODUCTS

MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. SBS-Modified Bituminous Sheet:

a. Bitufa (Netherlands), 'Standard Plus', or approved equal.

SBS-MODIFIED BITUMINOUS SHEET

A. SBS-Modified Bituminous Sheet: SBS-modified bituminous sheet, smooth surfaced, dusted with fine parting agent on both sides; suitable for installation method specified; manufacturer's recommended thickness and weight for use and application intended, but not less than 4mm thick, and of reinforcing type as follows:

1. Use: Single ply membrane roofing and upstand base flashings.
2. Reinforcing: Woven or nonwoven polyester mat.

B. Physical Properties: Provide SBS-modified bituminous membrane material with a minimum mass of 4.5 kg/m2 and the following properties when tested according to ASTM D 5147:

1. Thickness: 4 mm, minimum.
2. Tensile Strength: 700 N/50mm in each direction.
3. Elongation at Maximum Load: 4.5 percent minimum in each direction.
4. Tear Strength: 100 N minimum.
5. Water Absorption: Less than 0.2 percent mass change.
6. Low-Temperature Flexibility: Pass at minus 20 deg.C.

AUXILIARY MEMBRANE MATERIALS

A. General: Furnish primers, bitumen adhesives, sealants, cants, fasteners, etc., and other auxiliary materials, as recommended by roofing membrane manufacturer for intended use and application, and compatible with SBS-modified bituminous membrane roofing.

PROTECTION SHEET

A. Protection Sheet: Woven or nonwoven polypropylene or polyester fabric mat, water permeable and resistant to UV degradation. Type and weight as recommended by roofing membrane manufacturer for use and application intended.

AGGREGATE BALLAST

A. Aggregate Ballast: Provide aggregate that will withstand weather exposure without significant deterioration and will not contribute to degradation of insulation or membrane, and of the following type and size:

1. Type: Smooth, washed, riverbed gravel or crushed stone acceptable to the Engineer.
2. Size: Ranging from 16 to 25 mm.

ROOF PAVERS

A. Roof Pavers: Factory-cast, square-edged units, specially manufactured for use as roof pavers and acceptable to the Engineer:

1. Precast Concrete:

   a. Size: 300 x 300 mm, unless otherwise indicated.
   b. Thickness: 30 mm, unless otherwise indicated.

2. Precast Terrazzo:

   a. Size: 300 x 300 mm, unless otherwise indicated.
   b. Thickness: 30 mm, unless otherwise indicated.

3. Paver Colors and Textures: To Engineer's approval.
4. Paver Supports: Manufacturer’s standard proprietary high-density neoprene or polyethylene paver support pads.

PART 3 - EXECUTION

EXAMINATION

A. Examine substrates, areas, and conditions under which roofing will be applied, for compliance with requirements.

B. Verify that roof openings and penetrations are in place and set and braced and that roof drains, if any, are properly clamped into position.

C. Verify that wood blocking, curbs, and nailers, if any, are securely anchored to roof deck at roof penetrations and terminations and match the thicknesses of insulation required.

D. Do not proceed with installation until after the minimum concrete curing period recommended by roofing membrane manufacturer.

E. Do not proceed with installation until unsatisfactory conditions have been corrected.

GENERAL INSTALLATION REQUIREMENTS

A. Install modified bituminous membrane roofing system according to roofing membrane manufacturer's written instructions and applicable recommendations.

1. Clean substrate of dust, debris, and other substances detrimental to membrane roofing installation. Remove sharp projections.

B. Cant Strips: Install 45-degree cant strips at junctions of modified bituminous membrane roofing with vertical surfaces, or angle changes greater than 45 degrees.

C. Coordinate installing roofing system components so roofing membranes and insulation are not exposed to precipitation or left exposed at the end of the workday or when rain is forecast.

ROOF MEMBRANE INSTALLATION

A. General: Install modified bituminous membrane over area to receive roofing, according to manufacturer's written instructions. Extend modified bituminous membrane over and terminate beyond cants.

B. Modified Bituminous Membrane: Install single ply modified bituminous membrane starting at low point of roofing system.

1. Application: Torch apply to substrate.

C. Laps: Accurately align sheets, without stretching, and maintain uniform side and end laps. Stagger end laps. Completely bond and seal laps, leaving no voids.

UPSTAND BASE FLASHING INSTALLATION

A. Install modified bituminous membrane upstand base flashing over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof, and secure to substrates according to roofing membrane manufacturer's written instructions and/or as indicated on Drawings.

1. Upstand base Flashing Application: Torch apply to substrate.

B. Unless otherwise indicated, extend upstand base flashing vertically, a minimum of 200 mm above roof membrane and 100 mm onto field of roof membrane.

C. Securely fasten modified bituminous membrane at top of upstand base flashing, and at terminations and perimeters of roofing.

1. Seal top termination of upstand base flashing as indicated.

PROTECTION SHEET INSTALLATION

A. Install protection sheet over modified bituminous membrane and/or board insulation as indicated, according to manufacturer's written instructions.

AGGREGATE BALLAST INSTALLATION

A. Deposit and spread ballast over protection sheet, and evenly to uniform thickness, taking care to avoid damage to bituminous roof membrane. Install ballast as soon as practicable after installing modified bituminous roof membrane, upstand base flashings and roof accessories.

1. Thickness: Minimum 50 mm layer.

ROOF PAVERS INSTALLATION

A. Install roof pavers over protection sheet, loose laid with well aligned joints, on paver support pads.

PROTECTING AND CLEANING

A. Protect modified bituminous membrane roofing and installed roofing system from damage and wear during remainder of construction period.

B. Correct deficiencies in or remove modified bituminous roofing that does not comply with requirements, repair substrates, reinstall roofing, and repair upstand base flashings to a condition free of damage and deterioration at time of Taking-Over and according to warranty requirements.

7.1.3 TILES ROOFING

Clay (Marseille butterfly type) or approved equal or similar to existing roofing tiles, on and including treated alum. Battens with single layer modified bituminous membrane and clay tile accessories, flashing and counter flashing as indicated or required at roof perimeters and abutments. Shop drawing required for Engineer's approval.

7.1.4 METAL ROOFING

Pitched roofing comprising: Stone enamel galvanized steel sheet, non-combustible, insulated sandwich panel roofing, on and including metal purlins; Single layer modified bituminous membrane with Metal panel roofing accessories, flashing and counter flashing as required at roof perimeters and abutments. Shop drawing required for Engineer's approval.

7.1.5 ROOF DRAINAGE

Aluminum sheet, eaves box gutter as indicated; on and including bedding laid to falls; include ends, joints, sealants and outlets. Shop drawing required for Engineer's approval.

7.1.6 ROOF ACCESSORIES

7.6.1 GENERAL

Proprietary roof accessory units, factory fabricated and assembled; installed complete as detailed and necessarily required; including sub frames and frames, kerbs, upstands and supports; anchorages; fixings and fasteners; flashings, counter-flashings and sealants; hardware, devices, accessories, trim, finishes and finishing; and all other related ancillaries as indicated or required.

7.6.2 SKY DOME

The characteristic of sky dome is according to BS or DTU or any equivalent approved regulations, it must be permanently closed & easy open in case of fire from the lower level by an electronic system or hydraulic or any system approved by the engineer.

7.1.7 FLASHING AND SHEET METAL

PART 1 - GENERAL

SUMMARY

A. The extent of flashing and sheet metal is indicated on Drawings and may include the following:

1. Metal counter flashing and base flashing (if any).
2. Metal wall flashing and expansion joints.
3. Exposed metal trim/fascia units.
4. Miscellaneous sheet metal accessories.
5. Elastic roof/wall expansion joint systems.

B. Roofing accessories installed integral with roofing are specified in "Membrane Roofing".

PROJECT CONDITIONS

A. Coordinate work of this section with interfacing and adjoining work for proper sequencing of each installation. Ensure best possible weather resistance and durability of work and protection of materials and finishes.

PART 2 - PRODUCTS

SHEET METAL FLASHING AND TRIM MATERIALS

A. Sheet Aluminum: Designation NS3, temper grade 0; BS 1470; flashings and cappings 22 SWg.

MISCELLANEOUS MATERIALS

A. Miscellaneous Materials and Accessories:

1. Fasteners: Same metal as flashing/sheet metal or other non- corrosive metal as recommended by sheet manufacturer. Match finish of exposed heads with material being fastened.
2. Bituminous Coating: Solvent-type bituminous mastic, nominally free of sulfur, compounded for 0.4 mm dry film thickness per coat.
3. Mastic Sealant: Polyisobutylene; nonhardening, nonskinning, nondrying, nonmigrating sealant.
4. Elastomeric Sealant: Generic type recommended by manufacturer of metal and fabricator of components being sealed.

5. Epoxy Seam Sealer: 2-part noncorrosive metal seam cementing compound, recommended by metal manufacturer for exterior/interior nonmoving joints including riveted joints.

6. Adhesives: Type recommended by flashing sheet manufacturer for waterproof/weather-resistant seaming and adhesive application of flashing sheet.

7. Paper Slip Sheet: Sized building paper.

8. Polyethylene Underlayment: Carbonated polyethylene film resistant to decay when tested in accordance with ASTM E 154.

9. Reglets: Metal or plastic units of type and profile indicated, compatible with flashing indicated, noncorrosive.

10. Metal Accessories: Provide sheet metal clips, straps, anchoring devices, and similar accessory units as required for installation of work, matching or compatible with material being installed, noncorrosive, size and gage required for performance.

11. Elastic Flashing Filler: Closed-cell polyethylene or other soft closed cell material recommended by elastic flashing manufacturer as filler under flashing loops to ensure movement with minimum stress on flashing sheet.

PART 3 - EXECUTION

INSTALLATION REQUIREMENTS

A. Underlayment: Where or aluminum is to be installed directly on cementitious or wood substrates, install a paper slip sheet of red rosin paper and a course of polyethylene underlayment.

B. Nail flanges of expansion joint units to curb nailers, at maximum spacing of 150mm centres Fabricate seams at joints between units with minimum 75mm overlap, to form a continuous, waterproof system.

CLEANING AND PROTECTION

A. Clean exposed metal surfaces, removing substances that might cause corrosion of metal or deterioration of finishes.

B. Protection: Upon completion of flashing and sheet metal work institute appropriate procedures for surveillance and protection of flashings and sheet metal work during construction to ensure that work will be without damage or deterioration other than natural weathering at time of final hand over.

7.2 WATER PROOFING PU COATING

PART 1 - GENERAL

DESCRIPTION

A. General

1. Furnish all labor, materials, tools, equipment, and services for PU water proofing coating as indicated, in accord with provisions of Contract Documents.

2. Completely coordinate with work of all other trades.

3. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

Quality Assurance

A. Manufacturer qualifications: Active in the manufacturing of similar type water proofing roof coating for a minimum of 3 years.

B. Installer qualifications:

1. Approved by manufacturer.
2. Labor to be with minimum of 3 years experience in similar application.

Submittals

A. Manufacturer's product data, including physical properties.

B. Manufacturer's installation instructions, certificate indicating that all materials are in compliance with specifications, recommendations for slab preparation prior to installation and recommendations for length of curing time after installation.

C. Manufacturer's written approval of installer.

D. Manufacturer's instructions for maintenance.

E. Guarantees.

Guarantees

A. Upon completion of work submit written guarantees.

1. Guarantee against manufacturing defects for a period of three years from date of acceptance.

2. Guarantee installation for three years from date of acceptance.

B. Remove and replace defective work, which does not comply with requirements at no additional expense to Owner.

PART 2 - PRODUCTS

MATERIALS

A. PU is a hybrid elastomeric waterproofing roof coating, new technology based on acrylic polyurethane emulsion. It forms a highly elastic, seamless membrane, offering excellent protection from moisture and standing water up to 10 years. It has excellent adhesion to most commonly used roof substrates such as concrete, asphalt membranes, cement tiles, acrylic, polyurethane paints etc. Shows very low water uptake and crack bridging ability

B. CHARACTERISTICS

Initial Total Solar Reflectance SR = 88% (300-2500nm) (ASTM 903-96 and ASTM G 159-98)
Solar Reflectance Visual SRvis = 93% (ASTM E 903-96 και ASTM G 159-98)
Solar Reflectance Near Infrared SRnir = 89% (ASTM E 903-96 και ASTM G 159-98)
Infrared Emittance Factor ε = 0,87 (ASTM E 408-71-2002)
Solar Reflectance Index SRI = 111 (ASTM E 1980-01)

C. SPREADING RATE
Total recommended consumption at least 1L/m² (two coats) on properly prepared surfaces.

D. LOW VOC (Volatile Organic Compounds) CONTENT
EU maximum VOC content limit values (Directive 2004/42/CE) for this product.

PART 3 - EXECUTION

INSPECTION/PREPARATION

SURFACE PREPARATION

Surfaces should be smooth, clean and dry, free from grease, dust, loose or flaking material. Cracks or joints should first be filled with Elastomeric Putty by Vitex.

New or weathered surfaces should be primed with Hyroof Primer for the stabilization of the substrate.

APPLICATION

Stir well before use. Applied with roller, emulsion brush or spay gun in two layers crosswise without dilution, with a total consumption of at least 1 Lt/m² all over the flat surface and on perimeter vertical parapets at least 30-40 cm in height. For protection and increase the lifetime of the waterproofing up to 10 years is required to use a polyester fabric 50-100 gr/ m² as a reinforcing material which is incorporated between the layers while the underlying surface is still wet. Recommended consumption of HyRoof Hybrid PU is 1,1 Lt/m² under reinforcement, topcoat 0,8Lt/ m², reaching a total consumption of at least 1,9 Lt/m².

Do not apply at temperature below 5°C, above 35°C and / or relative humidity above 70%.

Avoid application when rain or frost is expected in the next 48 hours.
It is touch-dry after 2-3 hours and can be recoated after 16 to 24 hours. Drying time depends on weather conditions (humidity and temperature).

Tools must be cleaned immediately after use with water and if needed with soapy water or a detergent.

A. After resilient athletic flooring is installed, and game lines are painted, spaces with this flooring shall be closed to all traffic by the Contractor to provide curing time for the adhesive and paint. This shall be for a specific period of time identified by the flooring manufacturer as part of required submittals.

B. Closely coordinate installation of resilient athletic flooring with floor sleeve systems specified in Section 11486. Floor sleeve system cover plates are removable/replaceable. Resilient athletic flooring shall be cut out to cover plate profiles at all locations and shall be adhesive attached to cover plate tops. Provide key access cutouts in resilient athletic flooring for all floor sleeve system cover plates.

Protection

A. Provide protection for finished work until building is ready for occupancy.

Final Cleaning

A. Clean as recommended by manufacturer when building is ready for occupancy.

7.3 WALL INSULATION

Provide the necessary damp proof coarse protection for the underground walls (Basements…etc) work to include the following:

- All materials and equipments applying one layer of plaster as specified
- Applying one Bitouminus layer of tack coat
- Applying one layer of SBS sheet 4mm thick with cartonal protection
- Construct 10cm hollow concrete block work wall
- The cost of labour
- In addition to above works to include also required excavation and backfilling with proper materials
- All needed works for a proper insulation as per instructions

7.4 GREEN ROOF

Green planted roofs to be executed and provided by specialized technicians and companies. The contractor to provide shop drawings and samples for approval before the start of these works.

7.5 JOINT SEALERS

PART 1 - GENERAL

SUMMARY

A. The extent of joint sealers and fillers is indicated or otherwise implied on Drawings and/or by the provisions of this Section.

SYSTEM PERFORMANCES

A. Provide joint sealers that have by long term production and installation been proved to establish and maintain watertight and airtight continuous seals on a permanent basis.

QUALITY ASSURANCE

A. Single Source Responsibility for Joint Sealer Materials: Obtain joint sealer materials from a single manufacturer for each type of product required.

B. Preconstruction Compatibility and Adhesion Testing: Submit samples of all materials that will contact or affect joint sealers to joint sealer manufacturers for compatibility and adhesion testing, as indicated below:

1. Use test methods standard with manufacturer to determine if priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealers to joint substrates.

    a. Perform tests under normal environmental conditions that will exist during actual installation.

2. Submit not less than 9 pieces of each type of material, including joint substrates, shims, joint sealant backings, secondary seals, and miscellaneous materials.

3. Schedule sufficient time for testing and analysis of results to prevent delay in the progress of the Work.

4. Investigate materials failing compatibility or adhesion tests and obtain joint sealer manufacturer's

written recommendations for corrective measures, including use of specially formulated primers.

D. Product Testing: Provide comprehensive test data for each type of joint sealer based on tests conducted by a qualified independent testing laboratory on current product formulations within a 24-month period preceding date of Contractor's submittal of test results to Engineer.

1. Test elastomeric sealants for compliance with requirements specified by reference to ASTM C 920. Include test results for hardness, stain resistance, adhesion and cohesion under cyclic movement (per ASTM C 719), low-temperature flexibility, modulus of elasticity at 100 percent strain, effects of heat aging, and effects of accelerated weathering.

2. For all exterior sealant systems, furnish test results performed on joint sealers after they have cured 1 year.

E. Preconstruction Field Testing: Prior to installation of joint sealants, field-test their adhesion to joint substrates as follows:

1. Locate test joints where indicated or, if not indicated, as directed by Engineer.

2. Conduct field tests for each application indicated below:

   a. Each type of elastomeric sealant and joint substrate indicated.
   b. Each type of non-elastomeric sealant and joint substrate indicated.

3. Arrange for tests to take place in presence of Engineer.

4. Test Method: Test joint sealers by hand pull method described below:

   a. Install joint sealants in 1500mm joint lengths using same materials and methods for joint preparation and joint sealant installation required for completed Work. Allow sealants to cure fully before testing.
   b. Make knife cuts as follows: A horizontal cut from one side of joint to the other followed by 2 vertical cuts approximately 50mm long at side of joint and meeting horizontal cut at top of 50mm cuts. Place a mark 25 mm from top of 50 mm piece.
   c. Use fingers to grasp 50mm piece of sealant just above 25mm mark; pull firmly down at a 90 degree angle or more while holding a ruler along side of sealant. Pull sealant out of joint to the distance recommended by sealant manufacturer for testing adhesive capability, but not less than that equaling specified maximum movement capability in extension; hold this position for 10 seconds.

5. Report whether or not sealant in joint connected to pulled out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate.

6. Evaluation of Field Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants which fail to adhere to joint substrates during testing.

7.

F. Field-Constructed Mock-Ups. Prior to installation of joint sealers, apply elastomeric sealants to the following selected building joints as indicated below for further verification of colors selected from sample submittals and to represent completed work for qualities of appearance, materials, and application:

1. Joints in field-constructed mock-ups of assemblies specified in other sections, which are indicated to receive elastomeric joint sealants specified in this section.

2. Retain mock-ups during construction as standard for judging completed construction.

PART 2 - PRODUCTS

MATERIALS, GENERAL

A. Compatibility: Provide joint sealers, joint fillers and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

B. Colors: Provide color of exposed joint sealers indicated or, if not otherwise indicated, as selected by Engineer from manufacturer's standard colors.

ELASTOMERIC JOINT SEALANTS

A. Elastomeric Sealant Standard: Select and provide manufacturer's standard chemically curing, elastomeric sealants of base polymer which complies with ASTM C 920 requirements, including those referenced for Type, Grade, Class, and Uses, and appropriate for purpose, condition and application of use.

MISCELLANEOUS JOINT SEALANTS

A. Acoustical Sealant for Concealed Joints: Manufacturer's standard, nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic rubber sealant recommended for sealing interior concealed joints to reduce transmission of airborne sound.

COMPRESSION SEALS

A. Preformed Foam Sealant: Manufacturer's standard preformed, precompressed, impregnated open-cell foam sealant manufactured from high-density urethane foam impregnated with a nondrying, water repellent agent; factory-produced in precompressed sizes and in roll or stick form to fit joint widths indicated and to develop a watertight and airtight seal when compressed to the degree specified by manufacturer; and complying with the following requirements:

1. Properties: Permanently elastic, mildew-resistant, nonmigratory, nonstaining, compatible with joint substrates and other joint sealers.
2. Impregnating Agent: Manufacturer's standard.
3. Density: manufacturer's standard.
4. Backing: Pressure sensitive adhesive, factory applied to one side, with protective wrapping.
5. Backing: Coated on one face with release agent serving as bond breaker for primary joint sealant.

MISCELLANEOUS MATERIALS

A. Primer: Provide type recommended by joint sealer manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint sealer- substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Provide nonstaining, chemical cleaners of type which are acceptable to manufacturers of sealants and sealant backing materials, which are not harmful to substrates and adjacent nonporous materials, and which do not leave oily residues or otherwise have a detrimental effect on sealant adhesion or in-service performance.

C. Masking Tape: Provide nonstaining, nonabsorbent type compatible with joint sealants and to surfaces adjacent to joints.

D. Accessory Materials for Fire-Stopping Sealants: Provide forming, joint fillers, packing and other accessory materials required for installation of fire stopping sealants as applicable to installation conditions indicated.

PART 3 - EXECUTION

EXAMINATION

A. Examine joints indicated to receive joint sealers, for compliance with requirements for joint configuration, installation tolerances and other conditions affecting joint sealer performance. Do not proceed with installation of joint sealers until unsatisfactory conditions have been corrected.

PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealers to comply with recommendations of joint sealer manufacturers.

INSTALLATION OF JOINT SEALERS

A. General: Comply with joint sealer manufacturers' printed installation instructions applicable to products and applications indicated, except where more stringent requirements apply.

B. Elastomeric Sealant Installation Standard: Comply with recommendations of ASTM C 962 for use of joint sealants as applicable to materials, applications and conditions indicated.

C. Installation of Sealant Backings: Install sealant backings to comply with the following requirements:

1. Install joint fillers of type indicated to provide support of sealants during application and at position required to produce the cross-sectional shapes and depths of installed sealants relative to joint widths which allow optimum sealant movement capability.

    a. Do not leave gaps between ends of joint fillers.
    b. Do not stretch, twist, puncture, or tear joint fillers.
    c. Remove absorbent joint fillers, which have become wet prior to sealant application and replace with dry material.

2. Install bond breaker tape between sealants and joint fillers, compression seals, or back of joints where adhesion of sealant to surfaces at back of joints would result in sealant failure.

3. Install compressible seals serving as sealant backings to comply with requirements indicated above for joint fillers.

D. Installation of Sealants: Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint widths which allow optimum sealant movement capability.

E. Tooling of Nonsag Sealants: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated, to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents, which discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

1. Provide concave joint configuration per Figure 6A in ASTM C 962, unless otherwise indicated or required.

2. Provide flush joint configuration per Figure 6B in ASTM C 962, where indicated or required.

    a. Use masking tape to protect adjacent surfaces of recessed tooled Joints.

3. Provide Recessed joint configuration per Figure 6C in ASTM C 962, of recess depth and at locations indicated or required.

F. Installation of Fire-Stopping Sealant: Install sealant, including forming, packing, and other accessory materials to fill openings around mechanical and electrical services penetrating floors and walls to provide fire-stops with fire resistance ratings indicated for floor or wall assembly in which penetration occurs.

CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealers and of products in which joints occur.

PROTECTION

A. Protect joint sealers during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of substantial completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealers immediately and reseal joints with new materials to produce joint sealer installations with repaired areas indistinguishable from original work.

7.6 EPDM INSULATION SHEET

EPDM SYSTEM DESCRIPTION

Product provided by this Section is 1.5mm – 1.6mm thick EPDM Ethylene Propylene Diene Terpolymer based elastomeric homogenous membrane.

PRODUCT

EPDM Membrane Waterproofing: Shall be Sure-Seal EPDM Membrane, sheet, between 1.5mm – 1.6mm thick, and shall meet or exceed the following requirements:

1. Tensile Strength: 1630 psi minimum, ASTM D 412
2. Ultimate Elongation: 520% minimum, ASTM D 412
3. Thickness Tolerance: + 10%, ASTM D 412
4. Tear Resistance: 230 lbf/in minimum, ASTM D 746
5. Brittleness Temperature: -45 F maximum, ASTM D 746
6. Water Absorption: 2% maximum, ASTM D 471, 7d at 158F
7. Permeance: 0.05 Perm maximum, ASTM E-96 B
8. Factory Seam Strength: Membrane rupture, ASTM D 816
9. Resistance to Heat Aging: Properties after 168 hrs. at 240F, ASTM D 573:
   Tensile Strength: 1600 psi minimum
   Ultimate Elongation 310% minimum
   Linear Dimensional Change: -0.4 mass % maximum
10. Ozone Resistance: ASTM D 1149
    No cracks after 100 ppm ozone,
    168 hrs at 104F,
    50% strain
11. Meets ASTM D 6134 specification

CHAPTER EIGHT
DOORS AND WINDOWS

8.1 WOOD DOORS WITH STEEL FRAMES

PART 1 - GENERAL

DESCRIPTION OF WORK

A. Extent and location of each type of wood door is shown on Drawings and in schedules.

B. Types of doors required include the following

1. Flush wood doors with plastic laminate faces.
2. Melamine doors and partitions.

C. Shop finishing of wood doors is included in this section.

D. Factory-preparation for door hardware (pre-machining) for wood doors, melamine doors and partitions is included in this section.

E. The following related work is specified elsewhere:

1. Door hardware installation.
2. Painting.

APPLICABLE CODES AND STANDARDS

ANSI/NWMA I.S.I	Industry standards for wood flush doors.
AWI	Quality Standard; Section 1300. Architectural woodwork quality standards.
BS 1186	Quality of timber and workmanship.
BS 4787: part 1	Dimensions of wood doorsets.
BS 5359	Methods of testing doors.

PART 2 - PRODUCTS

MATERIALS AND COMPONENTS - GENERAL

A. General: Provide wood doors, melamine doors and partitions complying with applicable requirements for kinds and types of doors indicated on drawings and as scheduled and specified.

B. Face Panels: Manufacturer's standard 2 or 3-ply face panels, unless otherwise indicated.

C. Exposed Surfaces: Provide decorative picture on of the shown on drawings or scheduled and as further specified and approved by the Engineer. The picture should be fixed by glue on boards on every door to be used printed on vinyl sheets 3 mm thick.

GENERAL FABRICATION REQUIREMENT

A. Transom and Side Panels: Wherever transom panels or side panels of wood are shown in same framing systems as wood doors, provide panels which match quality and appearance of associated wood doors, unless otherwise indicated. Fabricate matching panels with same construction, exposed surfaces and finish as specified for associated doors or by adding a picture on each door.

B. Openings: Cut and trim openings through doors and panels as shown. Comply with applicable requirements for kind(s) of doors required.

1. Openings: Factory cut openings. Trim openings with solid wood edgings and mouldings as indicated or required..
2. Factory install vision panel glass in prepared openings.

FLUSH DOORS: PLASTIC LAMINATE FACED

A. Typical Standard Doors:

1. Facing: Plastic laminate, premium grade complying with BS 3794; 1.5mm thickness.
   a. Colour, Texture and Pattern: as indicated or as selected by the Engineer from manufacturer's standard range with picture on.

2. Core: Precision planed softwood blockboard, butt-jointed and glued edge to edge to form a solid laminated construction.
3. Edge: exposed hardwood framed stiles, top and bottom rails; tongued and grooved to core.
4. Vision Panels: 6m thick glass as detailed.

ADHESIVE

A. Adhesive for all interior doors shall be of MR grade.

SHOP FINISH

A. Prefinish wood doors requiring transparent finish at factory or finish shop.

B. Doors requiring paint finish shall be sandpapered smooth, filled and primed at factory, ready for site painting.

C. Comply with recommendations of Applicable Codes and Standards for factory finishing of doors, including final sanding immediately before application of finishing materials.

1. Provide finishes of type indicated or agreed with the Engineer, to match samples held by the Engineer.

PRE-FITTING AND PREPARATION FOR HARDWARE

A. Pre-machine wood doors at factory.

B. Machine doors for hardware requiring cutting of doors.

PART 3 - EXECUTION

INSPECTION

A. Examine door frames and verify that frames are correct size and type and have been installed as required for proper hanging of corresponding doors. Do not proceed with installation until unsatisfactory conditions have been corrected.

INSTALLATION

A. Condition doors to average prevailing humidity in installation area prior to hanging.

B. Hardware: For installation refer to Door Hardware (Ironmongery) section of these specifications.

C. Manufacturer's Instructions: Install wood doors in accordance with manufacturer's instructions and as indicated and required.

D. Shop-Finished Doors: Restore finish on edges of shop finished doors before installation, if fitting or machining is required at the job site.

ADJUST AND CLEAN

A. Final Check:

1. Replace doors damaged during installation or which are warped, bowed or otherwise unacceptable.
2. Rehang or replace doors, which do not swing freely or operate smoothly and satisfactorily.

B. Protection: Provide protection and maintain conditions in a manner acceptable to the Engineer that will ensure doors and door hardware, are undamaged at time of Taking Over.

8.2 ALUMINUM DOORS AND WINDOWS

PART 1 - GENERAL

SUMMARY

A. Extent of aluminum doors and windows is indicated on Drawings and schedules.

B. Types required for the project include:

1. Exterior entrance doors and screens.
2. Interior doors and screens.
3. Exterior and interior windows.
4. Louvers.

C. Glass and glazing is specified elsewhere.

D. Lock cylinders are specified in the Door Hardware (Ironmongery) of the specification. Cost is included within the cost of each item.

SYSTEM DESCRIPTION

A. Performance Requirements: Provide aluminum assemblies that have been designed and fabricated to comply with the following specified performance characteristics. Compliance may be demonstrated by testing manufacturer's corresponding stock systems according to methods indicated.

B. Thermal Movement: Provide exterior systems capable of withstanding thermal movements resulting from an ambient temperature range of 5 deg C. to external maximum in direct sunlight of 70 deg. C.

C. Wind Loading: Provide assemblies capable of withstanding a uniform test pressure of 0.96 kPa (20 psf) inward and 0.96 kPa (20psf) outward when tested in accordance with ASTM E 330.

D. Exterior Entrances Transmission Characteristics: Provide entrance doors with jamb and head frames that comply with requirements indicated for transmission characteristics.

1. Air Leakage: Provide doors with an air infiltration rate per linear foot of perimeter crack, of not more than 0.0025 m3/s/m2 (0.50 CFM) for single doors and 0.005 m3/s/m2 (1.0 CFM) for pairs of doors when tested in accordance with ASTM E 283 at pressure differential of 75 Pa (1.567 psf).

E. Exterior Windows (and internal windows where applicable): Except as otherwise indicated, comply with air infiltration tests, water resistance tests, and applicable load tests, specified in ANSI/AAMA 302.9 for type and classification of window units required in each case; or, comply with applicable British Standards, i.e. BS 4873, 4315, Part 1.

F. Applicable Codes and Standards:

ASTM E 330	Structural Performance
ASTM E 331	Water Penetration
BS 1470	Aluminum Plate Sheet and Strip
BS 1474	Aluminum Bars, Extrusions
BS 4315	Methods of Tests for Resistance to Air and Water Penetration

SUBMITTALS

A. Product Data: Submit manufacturer's product specifications, technical data, standard details, and installation recommendations for each type of product required. Include the following information:

1. Fabrication methods.
2. Finishing.
3. Hardware.
4. Accessories.

B. Shop Drawings: submit shop drawings for fabrication and installation of Aluminum doors and windows, including the followings:

1. Elevations.
2. Details section of typical composite members.
3. Hardware, mounting heights.
4. Anchorages and reinforcements.
5. Expansion provisions.
6. Glazing details.

C. Samples: submit pairs of samples of each type and colour of Aluminum finish, on 300mm long sections of extrusions or formed shapes and on 150mm square sheets. Where colour or texture variations are anticipated, include 2 or more units in each set of samples indicating extreme limits of variations.

D. Certification: Provide certified test results showing that systems have been tested by a testing laboratory or agency acceptable to the Engineer, and comply with specified performance characteristics.

QUALITY ASSURANCE

A. Manufacturer's Qualifications: Unless otherwise acceptable to the Engineer provide doors and windows produced by a single manufacturer with not less than 5 years successful experience in the fabrication of assemblies of the type and quality required.

B. Design Criteria: Drawings indicate sizes, spacing of members, profiles and dimensional requirements of doors and windows. Minor deviations will be accepted in order to utilize manufacturer's standard products when, in the Engineer's sole judgment; such deviations do not materially detract from the design concept or intended performances.

PROJECT CONDITIONS

A. Field Measurements: Check openings by field measurement before fabrication to ensure proper fitting of work; show measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay in the work. Where necessary, proceed with fabrication without field measurements, and coordinate fabrication tolerances to ensure proper fit.

PART 2 - PRODUCTS

MANUFACTURERS

A. Available Manufacturers: subject to compliance with requirements, manufacturers offering products which may be incorporated in the work of a good factory.

MATERIALS

A. Aluminum Members: Provide alloy and temper recommended by the manufacturer for strength, corrosion resistance, and application of required finish; comply with ASTM B 221; BS 1474 for extrusions and ASTM B 209; BS 1470 for sheet or plate.

B. Fasteners: Provide fasteners of Aluminum or non-magnetic stainless steel (316) and fully compatible with Aluminum components, hardware, anchors and other components.

1. Reinforcement: Where fasteners screw-anchor into Aluminum less than 3mm thick, reinforce the interior with Aluminum or non-magnetic stainless steel to receive screw threads, or provide standard non corrosive pressed-in splined grommet nuts.

2. Exposed Fasteners: Use of exposed fasteners will not be acceptable unless specifically approved by the Engineer. For the application of hardware and subject to approval by the Engineer, use fasteners that match the finish of member or hardware being fastened.

    a. Provide Phillips flat-head machine screws for exposed fasteners.

C. Brackets and Reinforcements: Where feasible, provide high- strength aluminum brackets and reinforcements; otherwise provide non-magnetic stainless steel or hot-dip galvanized steel complying with ASTM A 386; BS 729.

D. Concrete/Masonry Inserts: Provide concrete and masonry inserts fabricated from cast-iron, malleable iron, or hot-dip galvanized steel complying with ASTM A 386; BS 729.

E. Compression Weather-stripping: Provide the manufacturer's standard replaceable compressible weather-stripping gaskets of molded neoprene complying with ASTM D 2000 or molded PVC complying with ASTM D 2287.

F. Sliding Weather-stripping: Provide the manufacturer's standard replaceable weather-stripping of wool, polypropylene, or nylon woven pile, with nylon fabric or aluminum strip backing, complying with AAMA 701.2.

G. Glass and Glazing Materials: Comply with requirements of Glass and Glazing section of the specifications.

COMPONENTS

A. Aluminum Door, Window and Louver Frames: Fabricate from manufacturer's standard tubular and channel frame assemblies, with welded or mechanical joints in accordance with manufacturer's standards; reinforce as necessary to support required loads. Provide and incorporate all Aluminum components, accessories, and anchorages as indicated and required.

1. Design: Provide doors and windows of thickness and design indicated.

2. Glazing: Fabricate doors and windows to facilitate replacement of glass or panels, without disassembly of frames. Provide snap-on extruded aluminum glazing stops, with exterior stops anchored for non-removal, or heat-resisting PVC glazing sections of a type approved by the Engineer.

B. Glass: Provide manufacturer's standard glass of the type and thickness indicated on drawings, or otherwise approved by the Engineer.

HARDWARE

A. General: Refer to Door Hardware section of the specification for hardware items other than those indicated to be provided by the aluminum entrance manufacturer.

B. Provide manufacturer's heavy-duty hardware units as indicated, scheduled, or required for operation of each door, of sizes, number, and type recommended by manufacturer and approved by the Engineer, for service required, finished to match door.

1. Keyed Cylinders: Provide mortise type, 5-pin tumbler, outside cylinder units with cast aluminum face;

a. co-ordinate and comply with master keying requirements specified in Door Hardware section of the specification.

2. Exterior Entrance Thresholds: Provide extruded aluminum threshold or size and design indicated in mill finish, complete with anchors and clips, coordinated with pivots and floor-concealed closers.

FABRICATION

A. General: Sizes of door, frame and window units, and profile requirements. are indicated on drawings. Variable dimensions are indicated, with maximum and minimum dimensions required to achieve design requirements and coordination with other work.

B. Prefabrication: Before shipment to the project site, complete fabrication, assembly, finishing, hardware application, and other work to the greatest extent possible. Disassemble components only as necessary for shipment and installation.

1. Preglaze door, and window units to greatest extent possible.
2. Do not drill and tap for surface-mounted hardware items until time of installation at project site.
3. Perform fabrication operations, including cutting, fitting, forming, drilling and grinding of metal work to

prevent damage to exposed finish surfaces. For hardware, perform these operations prior to application of finishes.

C. Welding: Grind exposed welds smooth and restore mechanical finish.

D. Reinforcing: Install reinforcing as required for hardware and necessary for performance requirements, sag resistance and rigidity.

E. Dissimilar Metals: Separate dissimilar metals with bituminous paint, or other separator that will prevent corrosion.

F. Continuity: Maintain accurate relation of planes and angles, with hairline fit of contacting members.

1. Uniformity of Finish: Abutting extruded aluminum members shall not have an integral color or texture variation greater than half the range indicated in the sample pair submittal.

G. Fasteners: Conceal fasteners.

H. Weather-stripping: For exterior doors and windows, provide compression weather-stripping against fixed stops; at other edges, provide sliding weather-stripping retained in adjustable strip mortised into door or window edge.

FINISHES

A. General: Refer to drawings/schedules for type of finish required.

B. Natural Anodized Finish: Provide non-specular as fabricated mechanical finish; chemical etch, medium matte; minimum thickness 0.025 mm clear anodic coating.

1. Provide natural anodized finish for flush aluminum unless otherwise indicated.

PART 3 - EXECUTION

INSTALLATION

A. Comply with manufacturer's instructions and recommendations for installation.

ADJUSTING

A. Adjust operating hardware to function properly, for smooth operation without binding, and for weather tight closure.

CLEANING

A. Clean the completed system, inside and out, promptly after installation, exercising care to avoid damage to coatings.

B. Clean glass surfaces after installation. Remove excess glazing and sealant compounds, dirt and other substances from aluminum surfaces.

PROTECTION

A. Institute protective measures required throughout the remainder of the construction

period to ensure that aluminum doors, screens and windows will be without damage or deterioration, other than normal weathering, at time of Taking-Over.

8.3 GLASS AND GLAZING

PART I - GENERAL

SUMMARY

A. Extent of glass and glazing work is indicated on Drawings and schedules.

B. Work in this section include glass and glazing for:

1. Aluminum doors and screens.
2. Aluminum windows.
3. Wood doors.

C. Mirror glass units are specified elsewhere.

SYSTEM DESCRIPTION

A. Provide glass and glazing that has been produced, fabricated and installed to withstand normal thermal movement, wind loading and impact loading (where applicable), without failure including loss or breakage of glass, failure of sealants or gaskets to remain watertight and airtight, deterioration of glass and glazing materials and other defects in the work.

QUALITY ASSURANCE

A. Glass and Glazing Standards: Conform and comply with relevant ASTM, ANSI, BS or alternative equivalent codes and standards acceptable to the Engineer which establish minimum qualitative and quantitative requirements for glass and glazing products and methods of installation for the types indicated and required.

B. Where the following products are indicated or required, provide glass which complies with relevant testing requirements of specific standards, and which are labeled and listed as such by a testing and inspection agency acceptable to the Engineer.

1. Safety glass.
2. Fire resistance rated wire glass.

C. Single Source Responsibility for Glass: To ensure consistent quality of appearance and performance, provide materials produced by a single manufacturer for each and condition of glass and glazing indicated or required.

PART 2 - PRODUCTS

GLASS PRODUCTS, GENERAL

A. Primary Glass Standard: Provide primary glass which complies with specific referenced standard requirements, including those indicated by reference to type, class, quality, and, if applicable, form, finish, mesh and pattern.

B. Sizes: Fabricate glass to sizes required for glazing openings indicated, with edge clearances and tolerances

complying with recommendations of glass manufacturer. Provide thicknesses indicated or, if not otherwise indicated, as recommended by glass manufacturer for application indicated.

PRIMARY GLASS PRODUCTS

A. Clear Float Glass: Type I (transparent glass, flat), Class 1 (clear), Quality q3 (glazing select), to FS DD-G-451 or BS 952: Section I: Part 3.

B. Tinted Float Glass: Type I (transparent glass, flat), Class 2 (tinted heat absorbing and light reducing), Quality q3 (glazing select):

C. Wired Glass: Type II (patterned and wired glass, flat), Class 1 (translucent), Quality q8 (glazing); complying with for resistance requirements; 6mm thick; of form and mesh pattern indicated below:

1. Polished Wire Glass: Form 1 (wired, polished both sides), Mesh m2 (square).

GLAZING SEALANTS, TAPES AND GASKETS

A. General: Provide manufacturer's standard products of types indicated or required and complying with specific referenced standards and the following requirements:

1. Compatibility: Select glazing sealants, tapes and gaskets of proven compatibility with other materials with which they will come into contact, including glass products, seals of insulating glass units, and glazing channel substrates, under conditions of installation and service, as demonstrated by testing and field experience.

2. Suitability: Comply with recommendations of sealant and glass manufacturers for selection of glazing sealants, tapes and gaskets which have performance characteristics suitable for applications indicated and conditions at time of installation.

3. Colors: Provide color of exposed sealants indicated or, if not otherwise indicated, as selected by Engineer from manufacturer's standard colors.

MISCELLANEOUS GLAZING MATERIALS

A. Compatibility: Provide materials with proven record of compatibility with surfaces contacted in installation.

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

C. Setting Blocks: Neoprene, EPDM or silicone blocks as required for compatibility with glazing sealants, 80 to 90 Shore A durometer hardness.

D. Spacers: Neoprene, EPDM or silicone blocks, or continuous extrusions, as required for compatibility with glazing sealant, of size, shape and hardness recommended by glass and sealant manufacturers for application indicated.

E. Edge Blocks: Neoprene, EPDM or silicone blocks as required for compatibility with glazing sealant, of size and hardness required to limit lateral movement (side-walking) of glass.

F. Compressible Filler Rods: Closed-cell or waterproof jacketed rod stock of synthetic rubber or plastic foam, flexible and resilient, with 35-69 kPa compression strength for 25 percent deflection.

PART 3 - EXECUTION

EXAMINATION

A. Inspect work of glass framing assembling for compliance with manufacturing and installation tolerances, including those for size, squareness, offsets at corners; for presence and functioning of weep system; for existence of minimum required face or edge clearances; and for effective sealing of joinery. Do not allow glazing work to proceed until unsatisfactory conditions have been corrected.

PREPARATION

A. Clean glazing channels and other framing members to receive glass, immediately before glazing. Remove coatings, which are not firmly bonded to substrates. Remove lacquer from metal surfaces where elastomeric sealants are indicated for use.

GLAZING, GENERAL

A. Comply with combined printed recommendations of glass manufacturers, of manufacturers of sealants, gaskets and other glazing materials, except where more stringent requirements are indicated, including those of referenced glazing standards.

B. Glazing channel dimensions as indicated in details are intended to provide for necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by job conditions at time of installation.

C. Protect glass from edge damage during handling and installation; use a rolling block in rotating glass units to prevent damage to glass comers. Do not impact glass with metal framing. Use suction cups to shift glass units within openings; do not raise or drift glass with a pry bar. Rotate glass with flares or bevels along one horizontal edge, which would occur in vicinity of setting blocks so that these are located at top of opening. Remove from project and dispose of glass units with edge damage or other imperfections of kind that, when installed, weakens glass and impairs performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant substrate testing.

GLAZING

A. Install setting blocks of proper size in sill rabbet, located one quarter of glass width from each corner, but with edge nearest corner not closer than 150 mm from corner, unless otherwise required. Set blocks in thin course of sealant, which is acceptable for heel bead use.

B. Provide spacers inside and out, of correct size and spacing to preserve required face clearances, for glass sizes larger than 1250 mm length plus height, except where gaskets or glazing tapes with continuous spacer rods are used for glazing. Provide 3 mm minimum bite of spacers on glass and use thickness equal to sealant width, except with sealant tape use thickness slightly less than final compressed thickness of tape.

C. Provide edge blocking to comply with requirements of referenced glazing standard, except where otherwise required by glass unit manufacturer.

D. Set units of glass in each series with uniformity of pattern, draw, bow and similar characteristics.

E. Provide compressible filler rods or equivalent back-up material, as recommended by sealant and glass manufacturers, to prevent sealant from extruding into glass channel weep systems and from adhering to joints back surface as well as to control depth of sealant for optimum performance, unless otherwise indicated.

F. Force sealants into glazing channels to eliminate voids and to ensure complete "wetting" or bond of sealant to glass and channel surfaces.

G. Tool exposed surfaces of sealants to provide a substantial "wash" away from glass Install pressurized tapes and gaskets to protrude slightly out of channel, so as to eliminate dirt and moisture pockets.

H. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage to ensure that gasket will not "walk" out when installation is subjected to movement.

I. Miter cut wedge-shaped gaskets at corners and install gaskets in manner recommended by gasket manufacturer to prevent pull away at corners; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

J. Lock-Strip Gasket Glazing: Comply with gasket manufacturer's printed recommendations. Provide supplementary wet seal and weep system unless otherwise indicated.

PROTECTION AND CLEANING

A. Protect exterior glass from breakage immediately upon installation by use of crossed streamers attached to framing and held away from glass. Do not apply markers to surfaces of glass. Remove non permanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove immediately by method recommended by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less often than once a month, for build-up of dirt, scum, alkali deposits or staining. When examination reveals presence of these forms of residue, remove by method recommended by glass manufacturer.

D. Remove and replace glass which is broken, chipped, cracked, abraded or damaged in other ways during construction period, including natural causes, accidents and vandalism.

E. Wash glass on both faces not more than 4 days prior to date scheduled for inspections intended to establish date of substantial completion in each area of project. Wash glass by method recommended by glass manufacturer.

8.4 DOOR HARDWARE (IRONMONGERY)

PART 1 - GENERAL

DESCRIPTION OF WORK

Section includes: Hardware for steel & Wooden Doors.

STANDARDS

A: BS EN 1303: 1998	Building Hardware Cylinders for Locks.
B: BS 7352: 1990	Specification for strength and durability performance of metal hinges for side hung applications and dimensional requirements for template drilled hinges.
C: BS 3621: 1980	Defines what constitutes a minimum standard of good security within a lock.
D: BS 5872: 1980	Specifications for locks and latches for doors in buildings.

E: BS EN 1125	Panic exit devices – requirements and test methods.
F: BS 1154: 1997	Controlled door closing devices requirements and test methods.
G: BS 476	Applicable to all fire rated building materials and structures. This test is a must whenever fire rated elements are requested.
H: Fire Rating	All hardware used on fire rated doors should comply to same standards of fire rating as doors and in specific of same fire rating hours.

SUBMITTALS

A. Product Data: Include installation details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings:

1. Details of electrified door hardware. Include location, sequence of operation, and interface with other building control systems.

2. Indicate type, locations and mounting heights of each type of hardware as scheduled, catalogue cuts, electrical characteristics and connection requirements.

3. Submit manufacturers parts, lists and templates.

C. Samples for Selection: Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available for each type of door hardware indicated.

D. Samples for Approval: For exposed door hardware, representative of each type required, in specified or selected finish, full size. Tag with identification for coordination with the Door Hardware Schedule.

1. Submit samples before submission of the Door Hardware Schedule.

E. Door Hardware Schedule: Prepared by or under the supervision of door hardware supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening.

F. Keying Schedule: Prepared by or under the supervision of door hardware supplier, detailing final keying instructions for locks. Include keying diagram and index each key set to unique door designations.

G. Manufacturers Installation Instruction: Submit special procedure, perimeter conditions, requiring special information.

QUALITY ASSURANCE

A. Source Limitations: Obtain all door hardware from a single manufacturer or supplier, unless otherwise indicated.

PART 2 - PRODUCTS

MATERIALS AND FABRICATION - GENERAL

A. Hand of door: The Drawings show the direction of slide, swing or hand of each door leaf. Provide each item of hardware for proper installation and operation of the door swing as shown.

B. Manufacturer's Name Plate: Do not use products which have manufacturer's name or trade name displayed in a visible location.

C. Products : Provide manufacturer's standard catalogue products, conforming to templates, and generally prepared for machine screw installation. Do not provide hardware which has been prepared for self-tapping sheet metal screws.

D. Provide screws for installation with each hardware item. Provide Phillips flathead screws except as otherwise required or approved by the Engineer. Finish exposed (exposed under any condition) screws to match the hardware finish or, if exposed in surfaces of other work, to match the finish of such other work as closely as possible.

E. Concealed Fasteners: Provide concealed fasteners for hardware units which are exposed when the door is closed, except to the extent no standard units of the type specified are available with concealed fasteners. Do not use through bolts for installation where the bolt head or the nut on the opposite face is exposed in other work .

F. Tools for Maintenance: Furnish two complete sets of any specialized tools as needed for Employer's continued adjustment, maintenance, and removal and replacement of hardware.

G. HARDWARE FINISHES

1. General: Exposed surfaces of hardware shall have manufacturer's standard satin anodized or stainless steel finish as indicated by the components listed in the Door Hardware Schedule.

COMPONENTS

A. GENERAL HARDWARE REQUIREMENTS

Where not specifically indicated, comply with applicable BS standards for each type of hardware required. Provide each type of hardware with accessories as required for the applications indicated and for complete, finished operational door.

1. Templates: Furnish templates or physical hardware items to door and frame manufacturers sufficiently to avoid delay in work.
2. Reinforcement Units: Furnished by door and frame manufacturers; coordinated by hardware supplier.
3. Fasteners: Furnished as recommended by hardware manufacturers to comply with application involved (steel, wood,…), and as required to secure hardware.
4. Hand of door: The drawing shows the direction of swinging or hand of each door leaf. Furnish each item of ironmongery for proper installation and operation of the door movement as shown.
5. Product finishes: the product finish to be as indicated in schedule as selected from manufacturers wide range of finishes.

B. HINGES, BUTTS AND PIVOTS:

Provide hinges, Butts and pivots as follows:

Number of Hinges: Unless otherwise indicated, supplier should provide number of hinges per leaf to comply with his product fire rating test / certificate. A proof of such test should be presented.

As a general recommendation, three hinges should be provided for net leaf size of 2135mm X 915mm and a fourth hinge for bigger size.

1. **Type of Hinges:**
   a. Provide full mortise 5-knuckle, Two ball bearing hinges standard weight, stainless steel in

compliance with BS7352 : 1990 class 9.

b. Provide full mortise rising hinges ,standard weight, stainless steel.

2. **Hinge size**: Unless otherwise indicated, or specified provide door hinge that comply with the requirements of and are sized in compliance with BS7352: 1990, being 4" x 3" x 3mm.

3. **Screws:** Furnish Philips Flat – Head machine screws for installation of units, except furnish Philips flat-head all purpose or wood screws for installation of units into wood. Finish screw heads to match surface of hinges or pivots.

4. **Hinge pins:** Unless otherwise specified, provide hinge pins as follows:
   a. Interior doors:removable stainless steel pin
   b. Exterior doors: non-removable pin

5. **Pivots:** As recommended by manufacturer for size and weight and thickness of door, also check related drawings for further details.

C. LOCKS AND LATCHES:

1. Unless otherwise indicated or specified, provide locks and latches that comply with BS 5872: 1980.
2. Strikes: Provide manufactures standard strikes for each latch or lock bolt: with curved lip executed to protect frame, finish to match ironmongery sets.
3. Rabbeted doors: where rabetted door stiles are indicated, provide special rabetted front on lock and latch units and bolts.
4. Provide 76mm Euro profile mortise Sashlock case, 57mm backset 57mm centers, brass follower to suit 8mm spindle, with adjustable tension spring to suit heavy unsprung or sprung lever furniture meeting BS5872 and fire rated to BS476, Stainless steel finish.
5. Provide 76mm Euro profile mortise dead lock case 57mm back set, to meet BS5872 and fire rated to BS 476, stainless steel finish.
6. Provide 76mm mortise bathroom lock, 57mm backset centers with reversible latch bolt, to suit 8mm spindle with adjustable tension spring, and dead bolt follower 5mm, stainless steel.
7. Provide 76mm Euro profile mortise nightlatch lock case,57mm backset 57mm centers,brass follower to suit 8mm spindle,brass latchbolt,automatic locking action without key,when door is closed with latch bolt out,reversible latch bolt,cylinder and lever handle,to suit either hand of door.
8. Equip locks with euro profile double cylinder, 5 pins with length to match with the door thickness and the related installed accessories.
9. Equip locks with Euro-profile single cylinder,5 pins with length to match with the door thickness and the related installed accessories.
10. Equip locks with Euro-profile single cylinde plus thumbturn,5 pins with length to match with the door thickness and the related installed accessories.
11. All locks are to differ and are ensuite to grand master key, with 5 pin cylinders.
12. Provide 3 keys for each lock, finish as manufacturers standard unless otherwise indicated.
13. Provide thumbturn with indicator monitor and emergency release to comply with the provided bathroom lock, stainless steel finish.

D. FLUSH BOLTS AND DUST PROOF STRIKES:

1. **Flush Bolts:**
   a. Lever action manual flush bolt to comply with steel leaf application and fire rating. Manufacturer standard finish unless otherwise indicated.
   b. Automatic flush bolt to comply with steel leaf application and fire rating. Manufacturer standard finish unless other wise indicated.
   c. Lever action manual flush bolt to comply with wooden leaf application and fire rating. Manufacturer standard finish unless other wise indicated.
   d. Automatic flush bolt to comply with wooden leaf application and fire rating. Manufacturer standard finish unless other wise indicated.

2. **Dust proof strike:** provides dust proof strikes for foot bolts except where special threshold construction requires specific type. Finish as requested by the Engineer unless otherwise indicated.

E. LEVER HANDLES:

1. Provide one set 19mm diameter 130mm length, 71mm projection lever handle on 50mm diameter rose manufactured from stainless steel.

2. Provide lever handle with half-spindle on one side to comply with the provided night latch lockset and to be 19mm diameter 130mm length 71mm projection on 50mm diameter rose,spring loaded ,manufactured from stainless steel .

F. PULL HANDLES / PUSH PLATES/MIDPLATES/KICKPLATES:

1. **Pull Handles:** Provide 19mm diameter 225mm C/C pull handle bolt through. Manufactured from stainless steel sheet rolled. Mounting location as indicated on shop drawings.

2. **Push Plate:** Provide 350mm x150mm,1.2mm thick, stainless steel satin finish push plate. Round cornered with counter sunk screws. Mounting location as indicated on shop drawings.

3. **Midplates:** Provide 1.2mm thick, stainless steel satin finish with size to comply with the door width (DWx150mm) mid plate. Midplates to be round cornered with counter sunk screws. Mounting location as indicated on shop drawings.

4. **Kickplates:** Provide 1.2mm thick, stainless steel satin finish with size to comply with the door width (DWx200mm) kickplate. Kickplates to be round cornered with counter sunk screws. Mounting location as indicated on shop drawings.

G. EXIT DEVICES:

1. **General:** Unless otherwise indicated or specified, emergency exit devices shall comply with BS EN 1125 specification requirements for panic bolts and panic latches. And fire rated to BS 476.
   a. Cross bar exit device for single leaf with reversible panic latch and outside trim, silver finish. Location as indicated on hardware schedule.
   a. Cross bar Vertical rod panic bolt to be installed on double leaf doors with outside trim location as indicated on hardware schedule, silver finish.

H. DOOR CLOSER:

1. **General:** Unless otherwise indicated or specified, closers and door control devices shall comply with the applicable requirements of BS EN 1154: 1997 and finish shall be subject to the approval of the engineer.

2. **Specification of Unit:** Door closer with silver cover which features a cast iron body with a hardened steel rack and pinion incorporating needle roller bearing housed beneath a precision zinc die cast cover.And to have the following.
   a. Template and quick-fit back plate
   b. 2-4 adjustable strength size or size to suit door weight and dimensions
   c. Non-handed.
   d. 180 deg. Opening/controlled closing
   e. Separate adjustment of latch action & closing speed.
   f. Temperature compensation –15deg C to +40deg C.
   i. Matching arms.
   j. Quick release arm assembly
   k. Pre assembled arm assembly
   l. Tripacked for applications
      1. Regular, closer is fitted to the pull (hinge knuckle) face of the door.
      2. Transom mounted, closer is fitted to the transom on push face of the door.Bracket fitted to the door face.
      3. Parrallel arm, closer is fitted to the push (opposite to hinge knuckle) face of the door.Bracket is fitted to underside of head frame.
   m. Closer Cover design and finish is to be approved by the engineer

in charge.

I. DOOR SELECTOR (DOOR COORDINATOR):

Provide door selector to comply with Application involved and the BS requirements for fire rating and performance.Type and finish to be approved by the Engineer in charge.

J. DOOR STOP

1. General: Unless otherwise indicated or specified door stops shall comply with the latest British standard applicable.

2. Door Stop Units shall include but shall not be limited to door ironmongery as follows:
   a. Dome Stop
   b. Wall Bumpers
   c. Security Door Stop

K. DOUBLE ACTING FLOOR SPRING;

1. **General :** Unless other wise indicated or specified,double acting floor springs shall comply with the applicable requirements of the European standards for controlled door closing devices **BS EN 1154:1997** .Finish shall be subject to the approval of the engineer in charge.

L. ACCESSORIES:

- Provide Escutcheon for euro profile cylinder finish to match ironmongery sets.
- Provide room identification signs to comply with the application involved, shape and finish as approved by the Engineer in charge.
- Provide Hat and Coat Hook buffered, finish to match ironmongery sets.
- Provide: Rubber door silencer manufacturer standard type.
- Provide rubber seals for groove type frames manufacturer standard type.

EXAMINATION

A. Administrative requirements: coordination and project condition

B. Verify doors and frames are ready to receive door hardware and dimensions are as indicated on shop drawings.

PART 3 - EXECUTION

INSTALLATION

A. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Wherever cutting and fitting is required to install hardware onto or into surfaces which are later to be painted or finished in another way coordinate removal, storage and reinstallation or application of surface protection with finishing work specified in other sections. Do not install surface-mounted items until finishes have been completed on the substrate.

B. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

C. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

ACTIVE LEAF OF PAIRS OF DOORS

A. Active leaf of pairs of doors shall be RHRB except that where door leaves are unequal, active leaf shall be larger leaf.

HARDWARE MOUNTING HEIGHTS

A. Mount hardware units at heights generally in accordance with the following, except as otherwise required by the Engineer, or specifically indicated on drawings or required to comply with governing regulations, or avoid interferences

1. Lock Sets and Latches: 950 mm to center of lever or knob from floor.
2. Butt Hinges: 250 mm to bottom of lowest hinge from floor; 125 mm to top of upper hinge from top of door; space other hinges equally between lower and upper hinges.
3. Door Pulls: 1140 mm finish floor to center of pull; center line in 125 mm from edge of flush doors, and centered on stile of narrow stile glass doors.
4. Deadlocks: Center line of cylinder to align with center line of cylinder for lock sets, except where location conflicts with pull handle or push plate, then provide at 1520 mm from finished floor to centerline of cylinder.
5. Cross Bar Exit Devices: 910 mm for standard installations.
6. Push Rail Exit Devices: 1040 mm for standard installations.
7. Push Plate: 1220 mm finish floor to center of plate through mounted to pulls.
8. Flush Bolt Operating Mechanisms: Top bolt 1675 mm to 1830 mm above finished floor, bottom bolt 300 mm above finished floor.

A. Coordinate mounting heights with door and frame manufacturers. Use templates provided by hardware item manufacturer.

B. Install each ironmongery item in compliance with the manufacturers instruction and recommendations whenever cutting and fitting is required to install ironmongery onto or into surfaces which are later to be painted or finished in another way, coordinate removal, storage and reinstallation or application of surface protection. Do not install surface mounted items until finishes have been complete the substrates.

C. Set Units plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation. Separate aluminum and other corrodible metal surfaces from sources of corrosion of electrolytic action at points of contact with other materials. Drill and countersink units which are factory prepared for anchorage fasteners, space fasteners and anchors in accordance with manufacturer’s instructions or as directed.

ADJUST AND CLEAN

A. Adjust and check each operating item of hardware and each door, to ensure proper operation or function of every unit. Replace units which cannot be adjusted and lubricated to operate freely and smoothly as intended for the application made.

B. Final Adjustment: Wherever hardware installation is made more than one month prior to acceptance or occupancy of a space or area, return to the work during the week prior to acceptance or occupancy, and make a final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

C. Instruct Employer's Personnel in proper adjustment and maintenance of hardware and hardware finishes, during the final adjustment of hardware.

Hardware Schedule for Doors

Refer to Wooden Door Schedule, LEGEND & IRONMONGERY.

8.5 DECORATIVE DOOR FOR KG CLASSROOM

1. PROTECTION AND COVERING PANEL WITH DECORATIVE CUT OUTS

DESCRIPTION

Half-height decorative one colour door protection (Iron, Wave, Mountain or Cubic masks from antibacterial PVC achieving Bs2d0 fire rating with solid colour. Lightly textured surface finish, 2 mm thick. A protective film is specified to minimize cleaning before acceptance.

ENVIRONMENT

No heavy metals are used in its formulation, including lead or tin (insignificant levels, less than 50 ppm) or any CMR Cat. 1 or 2 substances. The calcium-zinc thermal stabilization process is used. The emission level of volatile substance in inside air has been tested according to ISO 16000 and is very low (A+) according to the French regulation (23 March 2011 No. 2011-321 Decree and 19 April 2011 Order). 100% of the product are recyclable.

COLOUR

Selected by Architects from manufacturer's standard range.

INSTALLATION METHOD

Glue, as per manufacturer's instructions.

2. INLAYED SIGNAGE

DESCRIPTION

Inlayed signage in half-door protection from rigid and antibacterial PVC achieving Bs2d0 fire rating with solid colour and textured surface 2 mm thick.

ENVIRONMENT

No heavy metals are used in its formulation, including lead or tin (insignificant levels, less than 50 ppm) or any CMR Cat. 1 or 2 substances. The calcium-zinc thermal stabilization process is used. The emission level of volatile substance in inside air has been tested according to ISO 16000 and is very low (A+) according to the French regulation (23 March 2011 No. 2011-321 Decree and 19 April 2011 Order). 100% of the product are recyclable.

COLOUR

Selected by Architects from manufacturer's standard range.

INSTALLATION METHOD

Glue, as per manufacturer's instructions.

8.6 MASTER KEY

A. LOCKSET KEYING

1. General: Unless otherwise indicated all locksets shall be master keyed to a system of grand master, master and sub-master. Keying provisions and specific requirements are to be reviewed, agreed and approved by Employer, prior to incorporation into final keying schedule

    a. Grand Master: Each entire building.
    b. Master: Each department of each building.
    c. Sub-Master: Each floor level of each building.

2. Construction Keying: Provide all locksets construction keyed.

    b. Turning a master key in a lockset shall negate all construction keys.

3. Keys: Provide and deliver the following keys, tagged and labelled, in a sealed container to the Employer:

    a. Lockset Keys: Three, plus one blank.
    b. Sub-Master Keys: Three.
    c. Master Keys: Three.
    d. Grand Master Keys: Two.

CHAPTER NINE
FINISHES

9.1 LATH AND PLASTER

PART 1 - GENERAL

SUMMARY

A. Extent of lath and plaster is indicated on Drawings and Schedules.

B. Types of work include:

1. Metal lathing.
2. Portland cement plastering.

QUALITY ASSURANCE

A. Field Construction Mock-up: Prior to installation of plaster work, fabricate mock-up panels for each type of finish and application required using materials, including lath accessories and support system (if any) indicated for final work. Build panels 1.2 m x1.2 m x full thickness in location indicated, or if not otherwise indicated, as directed by Engineer. Demonstrate the proposed range of colour, texture and workmanship to be expected in completed work. Obtain Engineer acceptance of panel's visual quality before start of work. Retain panel during construction as a standard for judging completed work.

APPLICABLE CODES AND STANDARDS

ASTM C 150 Specification for Portland Cement.
BS 12 Specification for ordinary and rapid hardening Portland cement.
BS 890 Building limes.
BS 1198,
BS 1199,
BS 1200 Building sands from natural sources.
BS 1369 Metal lathing (steel) for plastering.
BS 4049 Glossary of terms applicable to internal plastering, external rendering and floor screeding.
BS 4721 Specification for ready-mixed building mortars.
BS 5262 Code of practice for internal plastering.
BS 6452 Beads for internal plastering and dry lining.

PART 2 - PRODUCTS

LATH

A. Expanded Metal Lath: Fabricate expanded metal lath from galvanized steel sheet to produce lath complying with BS 1369 for type, configuration and other characteristics indicated below, with uncoated steel sheet painted after fabrication into lath.

1. Diamond Mesh Lath: Comply with the following requirements:

Configuration: Flat.
Weight: 1.60 kg/m2.

PLASTER ACCESSORIES FOR PORTLAND CEMENT PLASTER

A. General: Comply with material provisions of BS 1369 and BS 5262; coordinate depth of accessories with thicknesses and number of coats required.

B. Metal Corner Reinforcement: Expanded large mesh diamond mesh lath fabricated from tight coat galvanized sheet steel to comply with BS 5262, with weight 2.25 kg/m2 and formed to reinforce external corners of Portland cement plaster on exterior exposures while allowing full plaster encasement.

C. Metal Corner Beads: Small nose corner beads fabricated from tight coat galvanized sheet steel, synthetic coated fitted with PVC strip.

D. Casing Beads: Square-edged style, with expanded flanges and removable protective tape, of the following material:

1. Material: Zinc-coated steel with PVC strip.
2. Two-Piece type: Pair of casing beads with back flanges formed to provide slip joint action, adjustable for joint widths from 3 mm to 15 mm, with PVC edging.

PORTLAND CEMENT PLASTER MATERIALS

A. Base Coat Cements: Type as indicated below:

1. Portland cement, ASTM C 150, Type I or III; BS 12.

B. Finish Coat Cement: Type as indicated below:

1. Portland cement, ASTM C 150, Type I; BS 12.

C. Factory-Prepared Finish Coat: Manufacturer's standard product requiring addition of water only.

1. Product: Subject to compliance with requirements and approval of the Engineer.

D. Lime: Special hydrated lime for finishing purposes, ASTM C 206, Type S; or BS 890 Type.

E. Sand Aggregates: ASTM C 897; BS 1199.

MISCELLANEOUS MATERIALS

A. Water for Mixing and Finishing Plaster: Drinkable, free of substances capable of affecting plaster set or of damaging plaster, lath or accessories.

B. Bonding Agent for Portland Cement Plaster: ASTM C 932.

C. Plasticiser: Manufacturer's standard product, subject to compliance with requirements and approval of the Engineer may be used in accordance with manufacturer's recommendations and instructions.

PORTLAND CEMENT PLASTER MIXES AND COMPOSITIONS

A. General: Comply with ASTM C 926 or BS 5262 for Portland cement plaster base and finish coat mixes as applicable to plaster bases, materials and other requirements indicated.

B. Portland Cement Plaster Base Mixes and Compositions: Proportion materials for respective base coats in parts by volume for cementitious materials and in parts by volume per sum of cementitious materials for aggregates

to comply with the following requirements for each method of application and plaster base indicated. Adjust mix proportions below within limits specified to attain workability.

1. Three-Coat Work over Metal Lath: Base coats as indicated below:

   Scratch Coat: 1 part Portland cement, ½ part lime, 4 parts sand.

   Brown Coat: 1 part Portland cement, ½ part lime, 4 parts sand.

2. Two-Coat Work over Concrete Unit Masonry: Base coats as indicated below.

   Base coats: 1 part Portland cement, ½ part lime, 4 parts sand.

C. At Contractor's option, provide one of the following:

1. Job-Mixed Portland Cement Plaster Finish Coats: Proportion materials for finish coats in parts by volume for cementitious materials and parts by volume per sum of cementitious materials for aggregates to comply with the following requirements:

   a. 1 part Portland cement, ¾ - 1½ parts lime, 3 parts sand.

2. Factory-Prepared Portland Cement Finish Coats: Add water only; comply with finish coat manufacturer's directions.

D. Mixing: Mechanically mix cementitious and aggregate materials for plasters to comply with applicable referenced application standard and with recommendations of plaster manufacturer.

PART 3 - EXECUTION

INSTALLATION OF LATHING AND FURRING, GENERAL

A. Portland Cement Plaster Lathing and Furring Installation Standard: Install lathing and furring materials indicated for Portland cement plaster to comply with ANSI A42.3 or BS 5262.

METAL LATHING

A. Install expanded metal lath for the following applications where plaster base coats are required. Provide appropriate type, Configuration and weight of metal lath selected from materials indicated which comply with referenced lathing installation standards.

1. At junctions and joints between differing materials and forms of construction, and at all chases and other places where making good occurs.

   a. Install minimum 150 mm wide strip of lath, fixed to substrate on both edges at minimum 600 mm centres.

INSTALLATION OF PLASTERING ACCESSORIES

A. General: Comply with referenced lathing and furring installation standards for provision and location of plaster accessories of type indicated. Mitre or cope accessories at corners; install with tight joints and in alignment. Attach accessories securely to plaster bases to hold accessories in place and alignment during plastering.

B. Accessories for Portland Cement Plaster:

1. Corner Bead: Install at all external corners.

2. Casing Beads: Install at termination of plasterwork unless otherwise indicated.
3. Control joints: Install control joints at location indicated, or it not indicated, at locations complying with the following criteria and approved by the Engineer.

    a. Where an expansion or control joint occurs in surface of construction directly behind plaster membrane.
    b. Where distance between control joints in plaster surfaces exceed 5.5 m in either direction.
    c. Where area within Portland cement panels exceed 10 m2.
    d. Where Portland cement plaster panels sizes or dimensions change. Extend joints full width or height of plaster membrane.

PLASTER APPLICATION, GENERAL

A. Prepare monolithic surfaces for bonded base coats and use bonding compound or agent to comply with requirements of referenced plaster application standards for conditioning of monolithic surfaces.

B. Tolerances: Do not deviate more than 3 mm in 1.8 m from true plane in finished plaster surfaces, as measured by a 1.8 m straightedge placed at any location on surface.

C. Grout hollow metal frames, bases and similar work occurring in plastered areas, with base coat plaster material and prior to lathing where necessary. Except where full grouting is indicated or required for fire-resistance rating, grout 150 mm lengths at each anchorage.

D. Sequence plasters application with the installation and protection of other work, so that neither will be damaged by the installation of the other.

E. Apply thicknesses and number of coats of plaster as indicated; or as required by reference standards.

F. Concealed Plaster: Where plaster application will be concealed above suspended ceilings and similar locations, finish-coat may be omitted; where used as a base for adhesive application of tile and similar finishes, omit finish-coat and coordinate thickness with overall dimension as shown, and comply with tolerances specified.

PORTLAND CEMENT PLASTER APPLICATION

A. Portland Cement Plaster Application Standard: Apply Portland cement plaster materials, compositions, and mixes to comply with ASTM C 926 or BS 5262.

B. Number of Coats: Apply Portland cement plaster, of composition indicated, to comply with the following requirements:

1. Use three-coat work over metal lath.
2. Use two-coat work over the following plaster bases:

    a. Concrete unit masonry.
    b. Concrete cast-in-place or precast when surface complies with ASTM C 926 or BS 5262 for plaster bonded direct to solid base.

3. Finish Coat: Floated finish unless otherwise indicated; match Engineer sample.

C. Thickness:

1. Thickness of external plaster (render) shall be 25 mm, 3 coat application over metal lath, having smooth wood float finish.
2. Thickness of internal plaster shall be 15 mm, 2 coat application. Having smooth steel float finish.

D. Moist cure Portland cement plaster base and finish coats to comply with ASTM C 926 or BS 5262, including recommendations for time between coats and curing.

CUTTING AND PATCHING

A. Cut, patch, point-up and repair plaster as necessary to accommodate other work and to restore cracks, dents and imperfections. Repair or replace work to eliminate blisters, buckles, excessive crazing and check cracking, dry-outs, efflorescence, sweat-outs and similar defects, and where bond to the substrate has failed.

B. Sand smooth troweled finishes lightly to remove trowel marks and arises.

CLEANING AND PROTECTION

A. Remove temporary protection and enclosure of other work. Promptly remove plaster from doorframes, windows, and other surfaces, which are not to be plastered. Repair floors, walls and other surfaces, which have been stained, marred or otherwise damaged during the plastering work. When plastering work is completed, remove unused materials, containers and equipment and clean floors of plaster debris.

B. Provide final protection and maintain conditions, in a manner acceptable to the Engineer, which ensures plasterwork being without damage or deterioration at time of Taking-Over.

9.2 TILING WORKS

9.2.1 CERAMIC WALL & FLOOR TILE

PART 1 - GENERAL

SUMMARY

A. Definition: Tile includes ceramic surfacing units made from clay or other ceramic materials.

B. Extent of tile works is indicated on Drawings and Schedules.

C. Types of tile work in this section include the following:

1. Non slip ceramic floor tile and base (full mass ceramic).
2. Glazed ceramic wall tile.

D. Portland cement plaster scratch coat is specified in Lath and Plaster section of the specification.

E. Sealing expansion and other joints in tile work with elastomeric joint sealers is specified in Joint Sealers section of the specification.

QUALITY ASSURANCE

A. Source of Materials: Provide materials obtained from one source acceptable to Engineer for each type and colour of tile, grout and setting materials.

B. Field-Constructed Mock-Up: Before installing tile, erect mock-ups for each form of construction and finish required to verify selections made under sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution.

PART 2 - PRODUCTS

PRODUCTS, GENERAL

A. Standard for Ceramic Tile: comply with ANSI A137.1 "American National Standard Specifications for Ceramic Tile" for types and grades of tile indicated or BSCP 202 Tile Flooring and BS 6431 Ceramic Floor and Wall Tiles.

B. Standard for Tile Installation Materials: Comply with standard referenced with installation products and materials indicated or with BS 6431.

C. Colours, Textures and Patterns: For tile and other products requiring selection of colours, surface textures or other appearance characteristics, provide products to match characteristics indicated or, if not otherwise indicated, as selected by the Engineer from manufacturer's standard range.

1. Provide tile trim and accessories, which match colour and finish of adjoining flat tile.

TILE PRODUCTS

A. Vitrified Ceramic Floor Tile: Provide factory-mounted flat tile complying with BS 1286 type B.

1. Wear Surface: Smooth, non-slip.
2. Nominal Facial Dimension: As indicated.
3. Nominal thickness: As indicated, or 10 mm if not.
4. Face: Plain with square edges.

B. Glazed Ceramic Wall Tile: complying with BS 1281.

1. Wearing Surface: Smooth
2. Nominal Facial Dimensions: As indicated.
3. Nominal Thickness: As indicated, or 8 mm if not.
4. Face: Plain with cushion edges.

C. Base (Skirting): Cove base with square top edge; to match floor tiles; height as indicated, or 100 mm if not.

D. Trim Units: Provide tile trim units to match characteristics of adjoining flat tile and to comply with following requirements:

1. Size: As indicated, coordinate with sizes and coursing of adjoining flat tile, where applicable.

2. Shapes: As follows, selected from manufacturer's standard shapes:
   a. Base: Coved with square top edge, unless otherwise indicated. Provide external and internal corner angles as required.
   b. External Corners: Rounded, unless otherwise indicated.
   c. Internal Corners: Field-butted square corners.

SETTING MATERIALS

A. Thin-set Portland Cement Mortar: Where thin-set Portland cement mortar applications are indicated, use the following unless otherwise recommended by manufacturer or required by the Engineer:

1. Latex-portland cement mortar.
2. Epoxy mortar.
3. Organic adhesive.

MISCELLANEOUS MATERIALS

A. Tile Cleaner: Product specifically acceptable to tile manufacturer and grout manufacturer for application indicated.

MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with requirements of referenced standards and manufacturers including those for accurate proportioning of materials, water, or additive content; type of mixing equipment, selection of mixer speeds, mixing time, and other procedures needed to produce mortars and grouts of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

EXAMINATION

A. Examine substrates and areas where tile will be installed, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.

1. Verify that substrates for setting tile are firm, dry, clean, and free from oil or waxy films and curing compounds.

2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed before installing tile.

B. Do not proceed with installation until unsatisfactory conditions have been corrected.

FLOOR INSTALLATION METHODS

A. Ceramic Floor Tile and Base: Install tile to comply with requirements indicated below for setting bed methods, TCA installation methods related to types of subfloor construction, and grout types.

1. Portland Cement Mortar: ANSI A108.1

a. Bond Coat: Portland cement paste on plastic bed; or thin-set portland cement on cured bed, ANSI A108.5, at Contractor's option.
b. Concrete Subfloors, Interior: TCA F112.
c. Grout: Latex-portland cement.

2. Organic Adhesive: ANSI A108.4

a. Concrete Subfloors, Interior: TCA F116 .
b. Grout: Latex-portland cement.

WALL TILE INSTALLATION METHODS

A. Install types of tile designated for wall application to comply with requirements indicated below for setting bed methods, TCA installation methods related to subsurface wall conditions, and grout types:
1. Organic Adhesive: ANSI A108.4.

a. Solid Backing, Interior: TCA W223.

b. Grout: Latex-portland cement, with waterproofer.

CLEANING AND PROTECTION

A. Cleaning: Upon completion of placement of grouting, clean all ceramic tile surfaces so they are free from foreign matter.

1. Unglazed tile may be cleaned with acid solutions only when permitted by tile and grout manufacturer's printed instructions, but no sooner than 14 days after installation. Protect metal surfaces, cast iron and vitreous plumbing fixtures from effects of acid cleaning. Flush surface with clean water before and after cleaning.

B. Finish Tile Work: Leave finished installation clean and free of cracked, chipped, broken, unbonded or otherwise defective tile work.

C. Protection: When recommended by tile manufacturer, apply a protective coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage and wear.

1. Prohibit foot and wheel traffic from using tiled floor for at least 7 days after grouting is completed.

2. Before final inspection, remove protective coverings and rinse neutral cleaning from tile surface.

9.2.2 VINYL FLOORING AND BASE

9.2.2.1 VINYL FLOORING

PART 1 - GENERAL

DESCRIPTION

A. General:
1. Furnish all labor, materials, tools, equipment, and services for sheet vinyl flooring, in accord with provisions of Contract Documents.
2. Completely coordinate with work of other trades.
3. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

QUALITY ASSURANCE

A. Fire rating classification test : ASTM E84.

B. Abrasion resistance test: Use one of the following:
1. ASTM D1044: No wear thru with 1000 gram weight at 20,000 cycles.
2. Taber abraser using H-22 wheel under a 1000 gram load, depth of wear at 5000 cycles not to exceed an average of 0.178 mm (0.007 IN).

C. Applicator must be approved in writing by materials manufacturer.

D. Colors and patterns: The color and pattern of respective products specified in the section shall match appearance and as per the Engineering instruction.

SUBMITTALS:

A. Shop drawings:
   1. Layout showing joint pattern and orientation of directional patterns.
   2. Detail through integral coved base, base cap, and transition strip.

B. Product data:
   1. Manufacturer's literature for flooring and installation materials.
   2. Manufacturer's instructions for installation.

C. Samples:
   1. Samples of colors of flooring, transition strip, welding rod, and base cap strip.

D. Project data:
   1. Certification of applicator qualifications. The applicator should be qualified.

PART 2 - PRODUCTS

MATERIALS

A. Sheet vinyl flooring (SV): F.S. SS-T-312, Type III (Vinyl), smooth face, not less than 3 mm thick and type (Creation 70 Clic System) or approved equal, not less than 6mm thick. Sheet flooring shall conform to material requirements specified for vinyl tile. Foam backed sheet flooring is not acceptable.
   1. Flame spread (ASTM E84): Not more than 75.
   2. Smoke developed (ASTM E84): Not more than 450.
   3. Size: Maximum size produced by the manufacturer to provide the minimum number of joints.
   a. Furnish material in roll form, not less than 180 cm wide.
   4. Color and pattern of sheet flooring shall be of the same production run.

B. Base accessories:
   1. Fillet strip: 19 mm radius fillet strip compatible with the resilient sheet material.
   2. Cap strip: Extruded flanged, zero edge, vinyl reducer strip approximately 25 mm exposed height with 12.7 mm flange.

C. Base: as shown on drawings.

PART 3 - EXECUTION

INSPECTION

A. Examine substrate and conditions under which flooring is to be installed.

B. Do not proceed with installation until unsatisfactory conditions have been corrected.

C. Installation indicates acceptance of substrates and responsibility for performance.

PREPARATION

A. Test concrete substrate to assure moisture content of less than 3 percent. Assure that substrate is dry, clean and level prior to installation.

B. Remove foreign matter that would prevent adhesion. Remove curing compounds.

C. Sand concrete substrates with No. 3 sandpaper.

D. Remove projecting irregularities by chipping or grinding smooth. Grind off high spots.
E. Fill depressions and level the uneven surfaces with leveling compound.

F. Rinse subfloor and allow to dry thoroughly before applying adhesive.

INSTALLATION

A. Install flooring and base as scheduled for rooms, and under and behind movable casework and equipment. Don not install resilient flooring under fixed floor-mounted casework.

B. Provide integral radius coved at walls, columns, plasters, furred spaces, and other vertical surfaces.
   1. Install cove fillet strip behind integral bases.
   2. Provide cap strip at top of base.
   3. Form internal and external corners to the geometric shape generated by the cove at both square and radius corners.

C. Install material in accord with manufacturer's instructions, and approved layout drawings.

D. Install flooring in possible.
   1. Apply adhesive to substrate per manufacture's recommendations.
   2. Provide transition as required flooring abuts other flooring materials.

E. Install flooring in adhesive with accurate, tight seams. Reverse alternate sheets.

F. All sheets in one room or area shall be from same production run.

G. Mismatched materials will be rejected.

H. Welding seams: Heat welds all joints of and base using equipment and procedures developed by the flooring manufacturer.
   1. Welding shall consist of routing the joint, inserting a vinyl-welding rod into the routed space, and thermally fusing the rod into a homogeneous joint.
   2. Upon completion of welding, the surface across the joint shall finish flush, free from voids, and recessed or raised areas.
   3. Fusion of material: Joint shall be fused a minimum of 65 percent through the thickness of the material, and after welding shall meet the specified characteristics for the flooring.

CLEAN

A. When final building cleanup is being accomplished, clean flooring by mopping with detergent and water. Rinse with clean water. Apply no soap, wax, polish or other coating on conductive sheet floors. Buff floor and base.

B. Remove damaged flooring and provide new acceptable flooring at no additional expense to Owner.

9.2.2.2 VINYL RESILIENT BASE

PART 1 - GENERAL

DESCRIPTION

A. General:
   1. Furnish all labor, materials, tools, equipment, and services for resilient base in accord with provisions of Contract Documents.

QUALITY ASSURANCE

A. Base st: F.S. SS-W-4(1).

B. Base (Creation 70 Clic system) or approved equal.

SUBMITTAL

A. Samples:
   1. Material, pattern and color of each type base to match selections in Color Schedule and Color Palette.

PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's unopened containers indicating name, brand, color and pattern.

JOB CONDITIONS

A. Protect adjacent work from damage.

GUARANTEE

A. Written guarantee that material will not:
   1. Buckle, crack, lift, warp, shrink, change color, or disintegrate.
   2. Exude adhesives through joints or show any other defects attributable to materials or workmanship.

B. Remove defective areas and provide new acceptable material as approved by the Architect at no additional expense.

PART 2 - PRODUCTS

MATERIALS

A. Resilient base:
   1. Rubber top set, coved type; F.S. SS-W-40A (1), Type I, Style B.
   2. 3 x 100 mm x 6 mm wide at bottom.
   3. Factory formed external and internal corners.
   4. Provide continuous rolls.

B. Resilient base at carpet:
   1. Rubber top set, straight type; F.S. SS-W-40A (1), Type I, Style A.
   2. 3 x 100 mm.
   3. Factory formed external and internal corners.
   4. Provide continuous rolls.

C. Leveling compound: As recommended by resilient material manufacturer, compatible with adhesives.

D. Adhesives and primers: As recommended by resilient material manufacturer for type of substrate and location, free from lingering odor.

EXTRA MATERIAL

A. 150 cm of each color and type of base.

B. Provide materials in clearly labeled containers.

PART 3 - EXECUTION

INSPECTION

A. Verify that substrates are clean, free from moisture, and materials which may affect adhesion.

B. Carefully examine surfaces for defects and irregularities.

C. Installation constitutes acceptance of surfaces.

PREPARATION

A. Fill cracks, joints, with a water resistant non-crumbling patching compound. Trowel level.

INSTALLATION

A. Do not start in a room or space until work of other trades is complete. Coordinate with other floor and wall work and with ceiling installation.

B. Apply primer and adhesive as recommended by manufacturer.

C. Install base after wall material has dried out thoroughly.
   1. Provide base at intersections of floor and all vertical surfaces in areas shown or scheduled to receive base, where intersection is exposed to view.
   2. Set base straight and true.
   3. Fit into breaks and recesses.
   4. Neatly set or form all corners.
   5. Scribe to trim at door frames.
   6. Make joints tight.
   7. Install with top and bottom edge in firm contact with wall and floor.

ADJUST AND CLEAN

A. Immediately after application, remove surplus adhesive.

B. When materials have sufficiently seated, clean resilient base and adjoining surfaces in accord with manufacturer's recommendations.

C. Leave smooth and clean.

9.2.2.3 ANTI-SHOCK RUBBER WORKS

PART 1- GENERAL

1.1 DESCRIPTION

A. General:

1. Furnish all labor, materials, tools, equipment, and services for Anti-shock rubber tiles flooring, in accord with provisions of Contract Documents.
2. Completely coordinate with work of other trades.
3. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

B. Scope

The complete installation of a prefabricated tiles rubber sports surfacing system as manufactured.

C. Related work specified under other section.

1. Concrete Subfloors

   a. Slab Depression: Equal to thickness of selected flooring.
   b. Concrete Finish: shall be steel troweled, dense and finished smooth, not polished.
   c. Slab Tolerance: A tolerance of 1/8" (3mm) radius shall be maintained throughout. Floor Flatness and Floor Levelness (FF and FL) numbers are no recognized.
   d. No concrete curing, hardening or sealing agents shall be applied to the concrete subfloor.

2. Membrane Waterproofing

   a. Concrete subfloors on or below grade shall be adequately waterproofed, beneath, at perimeter walls, and on earth side of below grade walls.
   b. Type and extend of membrane shall be determined by the Project Engineer and installed by the General Contractor.

1.2 QUALITY ASSURANCE

American Society for Testing & Materials.

1. ASTM D 2047: Standard Test Method for Static Coefficient of Friction of Floor Surfaces.
2. ASTM D 2240: Standard Test Method for Rubber Property – Durometer Hardness.
3. ASTM E 648: Standard Test Method for Critical Radial Flux of Floor-Covering Systems Using a Radiant heat Energy Source.
4. ASTM E 662: Standard Test Method for Standard Test method for Specific Optical Density of Smoke Generated by Solid Materials.
5. ASTM F 970: Standard Test Method for Static Load Limit
6. ASTM F 1869: Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Sub-floor Using Anhydrous Calcium Chloride.

1.3 SUBMITTALS

A. Shop drawings:
   1. Layout showing joint pattern and orientation of directional patterns.
   2. Detail through integral coved base, base cap, and transition strip.

B. Product data:
   1. Manufacturer's literature for flooring and installation materials.
   2. Manufacturer's instructions for installation.

C. Samples:
   1. Samples of colors of flooring, transition strip, welding rod, and base cap strip.

D. Project data:
   1. Certification of applicator qualifications. The applicator should be qualified.

1.4 DELIVERY, STORAGE AND HANDLING

A. Materials must be delivered in manufacturer's original, unopened and undamaged packaging with identification labels intact.

B. The general contractor shall provide an area where stored materials can be maintained at 20 to 28 degrees C).

C. Store material upright in a secured area protected from exposure to harmful weather conditions on a clean, dry, flat surface protected from possible damage.

1.5 SITE CONDITIONS

A. The prefabricated rubber tiles flooring specified herein shall not be installed until all trades including, but not limited to, masonry, painting, plaster, tile, marble, terrazzo, carpentry, overhead mechanical trades, goals, scoreboard, electrical, and painters have finished in the installation area.

B. The area will be closed and secured from all foot traffic and trades for duration of the installation and curing period.

C. The building shall be enclosed, weather-tight, with permanent windows and lockable doors.

D. Permanent heat, light and ventilation shall be installed and operating prior to, during and after installation.

E. Subfloors shall be broom clean, dry and free from dirt, dust, oil, grease, paint, and alkali, concrete curing agents, hardening and parting compounds, old adhesive residue or other foreign materials.

F. Concrete tolerance of 1/8 inch (3mm) in ten foot (3m) shall be maintained throughout. High spots shall be ground level and low spots filled with a Portland base compound such as Ardex Feather Finish. No concrete curing hardening or sealing agents shall be applied to concrete.

G. Concrete must dry for a minimum of 30 days and "Determining Relative Humidity in Concrete with In-Situ Probes" not to exceed 85% respecting ASTM F2170. HVAC must be operational and with a constant temperature for 7 days prior to testing.

H. After completion, area to be kept locked by general contractor. No other trades or personnel to be allowed on floor until accepted by owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Material shall be prefabricated tiles rubber athletic flooring and highly resistant to UV or atmospheric agents.

   1. Only vulcanized, dual durometer tiles rubber with each layer having independent physical properties and biomechanical attributes will be accepted.
   2. Flooring must be highly resistant to UV and atmospheric agents.
   3. The Shore Hardness of the top layer surface will be greater than that of bottom layer with differentiated elasticity between the two.
   4. The surface layer shall be free recycled rubber granules and free of any different color fillers.
   5. Flooring surface shall be manufactured to maintain performance criteria, as stated by manufacturer, without defects, damage, or failure.
   6. Thickness shall be not less than 3 cm.

7. Color shall be by Engineer instruction.
8. Material shall be provided in tiles shape.
9.

9.2.3 PRECAST TERRAZZO

PART 1 - GENERAL

SUMMARY

A. Types of precast terrazzo work include:

1. Precast terrazzo tile flooring.

B. The Contractor shall engineer and design all precast terrazzo tile assemblies and installations, including under bed reinforcement, control joint and cold joint locations, and all other details and junctures with other materials and systems, to provide precast terrazzo tiling free from cracks, spalling, and other defects.

QUALITY ASSURANCE

A. Precast Terrazzo Tiles: Provide precast terrazzo tiles products obtained from a single source acceptable to the Engineer.

B. Setting and Grouting Materials: Provide materials obtained from one source for each type and colour of grout and setting materials.

C. Standards: Unless otherwise approved by the Engineer comply with specified provisions and recommendations of:

1. National Terrazzo and Mosaic Association, Inc. (NTMA).
2. Tile Council of America (TCA).

D. Manufacturer's Instructions: In addition to specified requirements, comply with precast terrazzo manufacturer's instructions and recommendations for substrates preparation, materials storage, mixing and application, finishing, and curing.

PART 2 - PRODUCTS

PRECAST TERRAZZO TILE PRODUCTS

A. Provide precast terrazzo tiles conforming with the following characteristic requirements:

1.	Dimensional Tolerances:	Face: + or -1 mm
2.	Warpage: Along any edge	+/- 1.5%
	on either diagonal	+/- 1.5%
3.	Wedging: Not to exceed	1.0%
4.	Water Absorption:	ASTM C 373
	Tile Face:	10%
	Whole Tile:	66% maximum
5.	Abrasive Hardness:	ASTM C 501, 14-28 depending on aggregates used.
6.	Breaking Strength:	ASTM C648, 1.72 MPa [250 psi]
7.	Mohs Hardness:	4-5 depending on aggregates used.
8.	Impact Resistance:	Very high resistance to damage by impact.

9. Precast Terrazzo Tile Production: Tile shall be produced from a manufacturing system, which includes

the following:

a. Mechanically vibrated in the molds.
b. Hydraulically pressed by 13.80 MPa [2,000 psi].
c. Curing totally immersing in water for at least 24 hours, after the initial set was taken place, or
d. Steam curing with 100% humidity for 14 hours at 150 degrees F.

10. The face layer of terrazzo tile shall have a minimum depth of 10 mm and shall include minimum 70% coverage of the tile face with marble aggregate.

SETTING MATERIALS

A. Portland Cement Mortar Installation Materials: Provide materials complying with ANSI A108.1.

GROUTING MATERIALS

A. Latex-Portland Cement Grout, ANSI A118.6. Colours to match matrix of each area of tile.

ACCESSORIES

A. Divider Strips: White zinc alloy. Width as required or as indicated.

B. Cleaner: Liquid, natural chemical cleaner, of formulation recommended by sealer manufacturer of type of precast terrazzo tiles used, and complying with NTMA requirements.

C. Interior Floor Sealer: Colourless, slip and stain resistant penetrating sealer with Ph factor between 7 and 8, that does not affect colour or physical properties of precast terrazzo tiles surface.

TERRAZZO FORMULATIONS

A. Aggregate: Provide natural, sound, crushed white Italian carrara marble chips, irregular in size and roughly cubiod in shapes without excessive flats or flakes, obtained from a source or supplier acceptable to the Engineer.

1. Samples: propose and submit samples of marble chippings for approval of size, colour gradation and composition, by the Engineer.

B. Backing: Ordinary Portland cement and sand mix in parts proportion of 1:5 by volume.

C. Face Matrix: White Portland Cement; ASTM C 150, Type I; or BS 12.

1. Use one brand of cement throughout, unless otherwise acceptable to the Engineer.

PART 3 - EXECUTION

PREPARATION

A. Clean and prepare substrate. Examine substrates to verify that surfaces are within required tolerances.

B. Prior to precast terrazzo tile installation, remove dust, curing compounds, oil and other foreign substances from substrates.

INSTALLATION, GENERAL

A. Perform all aspects of precast terrazzo tiles installation in accordance with any agreements reached at the pre-construction conference and any subsequent agreements reached as part of on-site review. Construction details shall be consistent with final submittals.

B. Place precast terrazzo tiles around obstructions to achieve continuous colour, pattern and finish.

C. Install divider strips and accessories in accordance with patterns indicated on drawings.

D. Install 5mm width control joint strips with sealant in patterns as required or as indicated on drawings, except not to exceed 9000mm centres maximum. Contractor should submit control joints location layout for approval.

E. Install abrasive inserts at locations shown on drawings, in accordance with insert manufacturer's instructions.

F. Straightness and flatness tolerance: 3mm in any 3 m span.

INSTALLATION

A. Install precast terrazzo tile in accordance with referenced standards for tile installation methods.

B. Jointing Pattern: Lay precast terrazzo in pattern shown. Align joints when adjoining tiles on floor, base, and walls. Provide uniform minimum joint widths.

C. Expansion and Control Joints: Provide openings for joints in locations as required. Comply with recommendations in referenced standards.

D. Cutting: Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so that plates, collars, or covers overlap tile.

E. Install mortar beds in accordance with ANSI A108.1. Install square edged precast terrazzo tile on cured mortar beds with latex-Portland cement mortar in accordance with ANSI A108.5.

1. Floors: Concrete - Methods F111.

F. Grout joints with latex Portland cement grout.

GRINDING AND POLISHING

A. Surfacing: Delay final fine grinding and finishing until heavy trade work is completed and construction traffic through the area is restricted. finish by fine grinding with abrasive grit of size required to match achieve a surface finish to approved sample.

CLEANING, SEALING, AND PROTECTION

A. Clean precast terrazzo units after installation, grouting and fine grinding operations are completed, complying with sealer manufacturer's instructions.

B. Apply sealer to cleaned precast terrazzo units surfaces to comply with sealer manufacturer's instructions.

C. Protect precast terrazzo units from damage and wear during construction operation.

FINAL CLEANING

A. Clean precast terrazzo units as recommended by manufacturer of sealer and machine buff if required by the Engineer, when building is ready for Taking-Over.

9.2.4 INTERIOR STONEWORK

PART 1 - GENERAL

SUMMARY

A. Extent of interior stonework is indicated on Drawings and in schedules.

B. Interior stonework includes the following:

1. Marble tile flooring including stair treads and risers.
2. Marble bases and thresholds.
3. Marble cladding facing to walls and columns.
4. Marble partitions at WC cubicles and urinals.

C. Stonework incorporated into joinery and architectural woodwork is specified in Section 6.2 - Joinery.

D. Sealing joints in interior stonework is specified in Joint Sealers section.

QUALITY ASSURANCE

A. Single Source Responsibility for Stone: Obtain each color, grade, finish, type and variety of stone from a single source with adequate resources to provide materials of consistent quality in appearance and physical properties, including the capacity to cut and finish material without delaying the progress of the Work.

B. Single Source Responsibility for Setting Materials: Obtain mortar ingredients of uniform quality and from one manufacturer for each cementitious and admixture component and from one source or producer for each aggregate.

C. Standards: Unless otherwise approved by the Engineer, comply with recommendation of:

1. Marble Institute of America (MIA), or the Stone Federation of the UK.

D. Field-Constructed Mock-Up: Prepare mock-ups for the following types of interior stonework. Purpose of mock-ups is further verification of selections made for color and finish under sample submittals and establishing standard of quality for aesthetic effects expected in completed work. Build mock-ups to comply with following requirements:

1. Locate mock-ups on site where indicated or, if not indicated, as directed by Engineer.

2. Build mock-ups for the following types of interior stonework:

   a. Marble flooring including base in form of panel as indicated on drawings.
   b. Marble wall cladding in form of panel as indicated on drawings, incorporating one vertical external corner.

3. Erect mock-ups in presence of Engineer.

4. Retain mock-ups during construction as a standard for judging completed stonework. Do not alter, move or destroy mock-up until work is completed.

PART 2 - PRODUCTS

MATERIALS, GENERAL

A. Comply with referenced standards and other requirements indicated applicable to each type of material required.

B. Provide premier quality matched stones obtained from an approved a single quarry for each type, variety, color and quality of stone required. Extract blocks from a single bed of quarry stratum, unless stones from randomly selected blocks are acceptable to Engineer for aesthetic effect.

C. Provide stones, which are free from vents, cracks, fissures, discoloration or other surface defects, which may adversely effect strength or appearance.

INTERIOR MARBLE

A. Match Engineer's approved sample for each marble type, including variety, group, color, surface finish, and other characteristics relating to aesthetic effects.

1. Marble: white Italian Carrara first choice; Polished finish

    a. Tile flooring, and staircase treads and risers.
    b. Bases, thresholds, etc.
    c. Fronts and partitions at Wc cubicles and urinals.

2. Marble: Greek Thassous, Crystal; polished finish

    a. Cladding and facing to wall and columns, including copings, returns, reveals, etc.

MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150 Type I; or BS.12. Provide gray or white cement as needed to produce mortar color required.

B. Hydrated Lime: ASTM C 207 Type S; or BS. 890

C. Aggregate: ASTM C 144; or BS. 1198/1200; non-staining and as indicated below:

1. For joints narrower than 6 mm use aggregate graded with 100 percent passing the No. 8 sieve and 95 percent the No. 16 sieve.
2. For pointing mortar use aggregate graded with 100 percent passing the No. 16 sieve.
3. White Aggregates: Natural white sand or ground white stone.

D. Colored Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with record of satisfactory performance in stone mortars.

E. Latex-Portland Cement Grout: ANSI A118.6, of the following composition and requirements:

1. Latex additive (water emulsion) serving as a replacement for part or all of gauging water, added at job site to prepackaged dry grout mix.
2. Manufacturers standard. Prepackaged latex Portland cement dry mix grout specified or supplied by latex manufacturer.

3. Provide grout colours approved by the Engineer to match colour of stone.

F. Water: Clean, non-alkaline and potable.

STONE ACCESSORIES

A. Stone Anchors: Stainless steel, type and size shown or, if not shown, as required and approved by the Engineer for securely anchoring and fastening interior stonework in place.

B. Setting Buttons: Lead or resilient plastic buttons, non- staining to stone, sized to suit joint thicknesses and bed depths of stonework involved.

C. Metal Edge Strips: Stainless steel strips, 3 mm wide at top edge, with integral provision for anchorage to mortar bed or substrate, unless otherwise indicated.

D. Cleaner: Provide stone cleaners of proper formulation for kinds of stones, finishes and applications indicated, as recommended by stone producer and, if sealer specified, by sealer manufacturer. Do not use acid-type cleaning agents or other cleaning compounds containing caustic or harsh fillers, except where expressly approved by stone producer for type of condition involved.

E. Sealer for Floors: Colourless, slip and stain resistant sealer which will not affect colour or physical properties of stone surface, as recommended by sealer manufacturer and by stone producer for application intended.

MORTAR AND GROUT MIXES

A. General: Do not add admixtures including coloring pigments, air-entraining agents, accelerators, retarders, water repellent agents, anti-freeze compounds, or calcium chloride, unless otherwise indicated.

B. Mixing: Combine and thoroughly mix cementitious materials, water and aggregates in a mechanical batch mixer; comply with ASTM, ANSI, BS or other acceptable standard, as applicable, for mixing time and water content.

C. Spotting Plaster: Stiff mix of molding plaster and water.

D. Setting Mortars and Grout for Flooring: Comply with mixing requirements of referenced ANSI or other acceptable standards for materials and installation methods.

E. Pointing Mortar: Provide pointing mortar mixed to match Engineer's approved sample and complying with requirements indicated above for setting mortar including type and the following:

1. Colored Pigmented Pointing Mortar: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1-to-10, by weight.

PART 3 - EXECUTION

EXAMINATION

A. Examine surfaces to receive stonework and conditions under which stonework will be installed. Do not proceed with installation until surfaces and conditions comply with requirements indicated or for execution of other work which affects stonework.

PREPARATION

A. Advise installers of other work about specific requirements relating to placement of inserts, reglets and similar items which will be used by Stonework Installer for anchoring and supporting stonework. Furnish Installers of other work with drawings or templates showing locations of these items.

B. Prior to setting, clean stone surfaces to remove soil, stains and foreign materials. Clean stones by thoroughly scrubbing stones with fiber brushes followed by a thorough drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh filler or abrasives.

SETTING STONE, GENERAL

A. Execute stonework by skilled tradesmen, and employ skilled stone fitters at the site to perform any necessary field cutting, as stones are set.

1. Use power saws to cut stones; produce exposed edges, which are cut straight and true.

B. Set stones to comply with requirements indicated on drawings and final shop drawings. Install anchors, supports, fasteners and other attachments indicated or necessary to secure stonework in place. Shim and adjust anchors, supports and accessories to set stones accurately in locations indicated with uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances.

C. Construction Tolerances: Set stones to comply with the following tolerances:

1. Variation from Plumb: For lines and surfaces of columns, walls and arises. Do not exceed 6mm in 3m, 10mm in a story height or 6m maximum, nor 15mm in 12m or more. For external corners, expansion joints and other conspicuous lines, do not exceed 6mm in any story or 6m maximum, nor 15mm in 12m or more.
2. Variation from Level: For grades indicated, horizontal grooves and other conspicuous lines, do not exceed 15mm in any bay or 6mm maximum, nor 20mm in 12m or more.
3. Variation of Linear Building Line: For position shown in plan and related portion of columns, walls and partitions, do not exceed 15mm in any bay or 500mm maximum, nor 20mm in 12m or more.
4. Variation in Surface Plane of flooring: Do not exceed 3mm from level or slope indicated, when tested with 3m straight edge.
5. Variation in Cross-Sectional Dimensions: For columns and thickness of walls from dimensions indicated, do not exceed minus 6mm nor plus 15mm.

D. Expansion and Control Joints: Provide for expansion and control joints of widths and at locations indicated, or as required.

1. Sealant for expansion and other joints is specified Joint Sealers section.

INSTALLATION OF STONE FLOORING

A. Extend flooring into recesses and under or behind equipment and fixtures, to form a complete covering without interruptions, except as otherwise shown. Terminate work neatly at obstructions, edges and corners without disrupting pattern or joint alignments.

B. Accurately form intersections and returns. Perform cutting and drilling of stones without marring visible surfaces. Carefully grind cut edges of stones abutting trim, finish or built-in items for straight aligned joints. Fit stones closely to electrical outlets, piping, fixtures and other penetrations so that plates, collars, or covers overlap stones.

C. Metal Edge Strips: Install at locations indicated or where exposed edge of stone flooring meets carpet, wood, or other flooring which finishes flush with top of stones.

D. Jointing Pattern for Tile: Unless otherwise shown, lay tile in grid pattern. Align joints when adjoining tiles on floor, base, walls and trim are same size. Layout tile work and center tile fields in both directions in each space or on each wall area.

E. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise shown.

F. Match tiles for color and other appearance characteristics by using tiles in same sequence as manufactured and packaged.

G. Stone Flooring Set in Portland Cement Mortar Bed:

1. Saturate concrete subfloor with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
2. Apply slurry of cement grout over surface of concrete subfloor about 15 minutes prior to placing setting bed. Limit area to avoid its drying out prior to placing setting bed. Mix slurry to a consistency similar to that of thick cream and consisting of either neat cement and water, or cement, sand and water. Do not exceed 1.5mm thickness for slurry coat.
3. Mix setting bed in proportions of 1:2:6 cement/lime/sand to quantity of water to produce a stiff mixture with a moist surface when setting bed is ready to receive stone flooring.
4. Spread and screed setting bed to uniform thickness indicated to produce subgrade elevations required for accurate shown. Mix and place only the amount, which can be covered with stone prior to initial set. Cut back, bevel edge, remove and discard setting bed material, which has reached initial set prior to placing stone.
5. Butter backs of stone flooring units until firmly bedded to proper finished floor elevation indicated. Set and level each stone unit in single operation, prior to initial set of cement bed; do not return to areas already set and disturb stone for leveling purposes.

H. Grouting Stone Flooring:

1. Mix grout consisting if factory prepared colour pigmented grout and liquid latex admixture in proportions recommended by manufacturer.
2. Grout joints in stone flooring units, except at expansion and control joints indicated as required to be filled with sealant. Finish grout flush with finished surface of stone. Fill all gaps and skips to produce a finished joint which is uniform in colour, smooth and without voids, pinholes, or low spots.
3. Remove grout spillage from face of stone as work progresses.
4. Cure grout by maintaining in a moist condition for 7 days.
5. Do not permit traffic on stone flooring during setting of units for at least 24 hours after final grouting of joints.

INSTALLATION OF INTERIOR WALL FACING AND TRIM; AND PARTITIONS

A. Erect interior wall facing and trim plumb and true with joints uniform in width and accurately aligned. Provide setting buttons as required to maintain joint width.

B. Erect interior WC cubicle fronts/ partition and urinal partitions plumb, true and accurately aligned as indicated.

1. Provide all necessary metal supports, brackets, anchors, fixings, fasteners and the like; chromium plated or stainless steel exposed finish.

C. Point joints after setting with pointing mortar of color indicated, mixed in proportions of 1-part Portland cement, 1-part time and 3-parts sand, unless otherwise indicated. Rub joints smooth with plastic tool.

ADJUSTING, CLEANING, AND SEALING

A. Remove and replace stonework of the following description.

1. Broken, chipped, stained or otherwise damaged stones.
2. Defective joints.
3. Stones and joints not matching approved samples and field constructed mock-ups.
4. Stonework not complying with other requirements indicated.

B. Replace in manner which results in stonework matching approved samples and field-constructed mock-ups, complying with other requirements and showing no evidence of replacement.

C. Clean interior stonework after setting, pointing, grouting and curing is complete; use procedures recommended by stone producer for types of application indicated.

D. Apply stone sealer to cleaned interior stone flooring in compliance with sealer manufacturer's instructions.

E. Protect interior stone flooring during construction period with Kraft paper or other heavy covering of type that will not stain or discolor stone.

F. Before inspection for substantial completion, remove protective covering and clean sealed surfaces using procedures and materials recommended by sealer manufacturer.

9.3 ACOUSTICAL CEILINGS WORKS

PART I - GENERAL

SUMMARY

A. Extent of each type of acoustical ceilings is shown on Drawings and schedules.

B. Types of ceilings specified in this section include the following:

1. Mineral fiber panel ceilings, exposed suspension.
2. Aluminum snap-in linear strip ceilings with sound absorption blanket.

QUALITY ASSURANCE

A. Fire Performance Characteristics: Provide acoustical ceiling components that are identical to those tested for the following fire performance characteristics, according to ASTM test method indicated, or BS 476 equivalent alternative by a testing and inspecting agency acceptable to the Engineer.

1. Surface Burning Characteristics: As follows, tested per ASTM E 84.

a. Flame Spread: 25 or less.
b. Smoke Developed: 50 or less.

B. Coordination of Work: Coordinate layout and installation of acoustical ceiling units and suspension system components with other work supported by, or penetrating through ceilings, including light fixtures, HVAC equipment, fire-suppression system components (if any), and partition systems (if any), etc.

PART 2 - PRODUCTS

ACOUSTICAL CEILING UNITS, GENERAL

A. Standard for Acoustical Ceiling Units: Provide manufacturer's standard units of configuration indicated which are prepared for mounting method designated and which comply with ASTM, BS or equivalent alternative standard requirements, acceptable to the Engineer, including those indicated by reference to type, form, pattern, grade (NRC or NIC' as applicable), light reflectance coefficient (LR), edge detail, and joint detail (if any).

B. Colors, Textures, and Patterns: Provide products to match appearance characteristics indicated or, if not otherwise indicated, as selected by Engineer from manufacturer's standard colors, surface textures, and patterns available for acoustical ceiling units and exposed metal suspension system members of quality designated.

C. Sound Absorption (Acoustical) Pads or Blanket: Provide manufacturer's standard sound absorptive pads or blanket, of thickness indicated, installed over metal grid or suspension components, and wrapped in or laid on black PVC sheet.

ACOUSTICAL CEILING TYPES

A. Mineral fiber Composition Panels; water felted, with standard washable finish: Manufacturer's standard plain texture and perforated pattern designs to be selected by Engineer; with other characteristics as follows:

1. Color/Light Reflectance: White/LR 1 (75% and over).
2. Grade: NRC 65 - 75.
3. STC Range: 40-44.
4. Edge Detail: Tegular.
5. Size: 600 mm x 600 mm x 19 mm.

B. Aluminum Snap-in Linear Metal Panels: Provide manufacturer's standard 100 mm wide unit as referenced. Colour to be selected by Engineer.

C. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to the following:

METAL SUSPENSION SYSTEMS, GENERAL

A. Standard for Metal Suspension Systems: Provide manufacturer's standard metal suspension systems of type, structural classification and finish indicated which comply with applicable ASTM C 635 or equivalent alternative requirements and approved by the Engineer.

B. Finishes and Colors: Provide manufacturer's standard factory-applied finish for type of system indicated. For exposed suspension members and accessories with painted finish, provide color indicated or, if not otherwise indicated, as selected by Engineer from manufacturer's full range of standard colors.

C. Miscellaneous Materials:

1. Attachment Devices: Type recommended by suspension system manufacturer for attachment or anchorage of ceiling hangers to structure, sized for 5 times design load indicated (ASTM C 635, Table 1, Direct Hung).

    a. Concrete Inserts: Inserts formed from hot-dipped galvanized sheet steel and designed for attachment to concrete forms and for embedment in concrete, with holes or loops for attachment at hanger wires.

2. Hanger Wire: Galvanized carbon steel wire, ASTM A 641, soft temper, prestretched, Class 1 coating, sized so that stress at 3- times hanger design load (ASTM C 635, Table 1, Direct Hung), will be less than yield stress of wire, but provide not less than 12 gage (2.7mm).

3. Edge Moldings and Trim: Metal or extruded plastic of types and profiles indicated or, if not indicated, provide manufacturer's standard molding for edges and penetrations of ceiling which fits with type of

edge detail and suspension system indicated.

a. For lay-in panels with reveal edge details, provide stepped edge molding which forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
b. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
c. For narrow faced suspension systems, provide suspension system manufacturer's standard edge moldings, which match width and configuration of exposed runners.

4. Hold-Down Clips for Non Fire-Rated Ceilings: For interior ceilings composed of lay-in panels weighing less than 4.9 kg/m2, provide hold-down clips spaced 600 mm centres on all cross tees.

5. Impact Clips: Where required provide manufacturer's standard impact clip system design to absorb impact forces against lay-in panels as recommended by panel manufacturer.

6. Acoustical Sealant: Resilient, non-staining, non-shrinking, non- hardening, non-skinning, non-drying, non-sag sealant intended for interior sealing of concealed construction joints.

PART 3 - EXECUTION

PREPARATION

A. Coordination: Furnish layouts for inserts, clips, or other supports required to be installed by other trades for support of acoustical ceilings.

1. Furnish concrete inserts and similar devices to other trades for installation well in advance of time needed for coordination of other work.

B. Pre-Installation Conference: Prior to start of acoustical ceiling installation, meet at project site with installers of related work, including lighting, ductwork, and similar work in ceiling plenum. Review areas of potential interference and resolve conflicts before proceeding with work. Co-ordinate ceiling layout with layout of other work, which penetrates or is supported by ceiling in each space of project.

C. Plan each layout to balance border widths at opposite edges of each ceiling area. Avoid use of less-than-half width units wherever possible. Comply with Engineer's approved reflected plans to greatest extent possible.

INSTALLATION

A. General: Install materials in accordance with manufacturer's printed instructions, and to comply with governing regulations, as indicated, and industry standards applicable to work.

B. Arrange acoustical units and orient directionally-patterned units (if any) in manner shown by reflected ceiling plans.

C. Install suspension systems to comply with ASTM C 636, with hangers supported only from building structural members. Locate hangers not less than 150 mm from each end and spaced 1200 mm along each carrying channel or direct-hung runner, unless otherwise indicated, leveling to tolerance of 3 mm in 3.60 m.

1. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eye-screws, or other devices which are secure and appropriate for substrate, and which will not deteriorate or fail with age or elevated temperatures.
2. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum, which are not part of supporting structural or ceiling suspension system. Splay hangers only where required

to miss obstructions and offset resulting horizontal force by bracing, counters playing or other equally effective means.

D. Install edge moldings of type indicated at perimeter of acoustical ceiling area and at locations where necessary to conceal edges of acoustical units.

1. Sealant Bed: Apply continuous ribbon of acoustical sealant, concealed on back of vertical leg before installing moldings.
2. Screw-attach moldings to substrate at intervals not over 400 mm centres and not more than 75 mm from ends, leveling-with ceiling suspension system to tolerance of 3 mm in 3.60 m. Miter corners accurately and connect securely.

E. Install acoustical panels in coordination with suspension system, with edges concealed by support of suspension members. Scribe and cut panels to fit accurately at borders and at penetrations.

1. Install hold-down clips in areas indicated, and in areas where required by governing regulations or for fire-resistance ratings; space as recommended by panel manufacturer, unless otherwise indicated or required.

F. Scribe and cut metal acoustical units for accurate fit at borders and at interruptions and penetrations by other work through ceilings. Stiffen edges of cut units as required to eliminate evidence of buckling.

G. Install snap-in acoustical units in coordination with suspension system and any exposed runner moldings.

H. Install metal acoustical panels in coordination with suspension system, with edges concealed by support of suspension members.

I. Install sound attenuation pads or blanket in areas indicated by approved reflected ceiling plans or room finish schedules. Lay directly on ceiling system in manner directed by the manufacturer in co-ordination with the ceiling installation.

CLEANING

A. Clean exposed surfaces of acoustical ceilings, including trim, edge moldings, and suspension members; comply with manufacturer's instructions for cleaning and touch-up of minor finish damage. Remove and replace work, which cannot be successfully cleaned and repaired to permanently eliminate evidence of damage, including dented or bent units.

B. Institute required protection for acoustical ceilings, including temperature and humidity limitations and dust control, so that work will be without damage and deterioration at time of Taking-Over.

9.4 GYPSUM WORKS

PART I - GENERAL

SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Tile backing panels.
3. Texture finishes.

ACTION SUBMITTALS

G. Samples:

1. Textured Finishes: [**Manufacturer's standard size**] for each textured finish indicated and on same backing indicated for Work.

PART 2 - PRODUCTS

PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

C. Low Emitting Materials: For ceiling and wall assemblies, provide materials and construction identical to those tested in assembly and complying with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

GYPSUM BOARD, GENERAL

A. Regional Materials: Gypsum panel products shall be manufactured within (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within (800 km) of Project site.

B. Regional Materials: Gypsum panel products shall be manufactured within (800 km) of Project site.

INTERIOR GYPSUM BOARD

A. Manufacturers: Subject to compliance with requirements.

B. Gypsum Wallboard: ASTM C 1396/C 1396M

1. Thickness: (12.7 mm)
2. Long Edges: [**Tapered**]

C. Gypsum Ceiling Board: ASTM C 1396/C 1396M:

1. Thickness: (12.7 mm)
2. Long Edges: [**Tapered**]

D. Abuse-Resistant Gypsum Board: ASTM C 1629/C 1629M.

1. Core: [**As indicated on Drawings**] [(12.7 mm), **regular type**].
2. Long Edges: Tapered.
3. Mold Resistance: ASTM D 3273, score of 10.

E. Moisture- and Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.

1. Core: [As indicated] [(12.7 mm), regular type] [(15.9 mm), Type X].
2. Long Edges: Tapered.
3. Mold Resistance: ASTM D 3273, score of 10.

EXTERIOR GYPSUM BOARD FOR CEILINGS AND SOFFITS

A. Exterior Gypsum Soffit Board: ASTM C 1396/C 1396M, with manufacturer's standard edges.

1. Manufacturers: Subject to compliance with requirements.

2. Core: [**As indicated**] [(12.7 mm)**, regular type**].

a. Waterproofing
b. Moisture and mold resistance
c. Fire resistance
d. Impact resistance

9.5 PAINTING WORKS

PART 1- GENERAL

SUMMARY

A. Extent of painting work is indicated and Drawings, schedules and herein, and includes surface preparation, painting, and finishing of exposed interior and exterior items and surfaces.

1. Surface preparation, priming, and finish coats specified in this section are in addition to shop priming and surface treatment specified under other sections.

B. Paint exposed surfaces whether or not colors are designated in "schedules," except where a surface or material is specifically indicated not to be painted or is to remain natural. Where an item or surface is not specifically mentioned, paint the same as similar adjacent materials or surfaces. If color or finish is not designated, the Engineer will select from standard manufacturer's colors or finishes available.

1. Painting includes field painting exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment.

C. Painting is not required on prefinished items, finished metal surfaces, concealed surfaces, operating parts, and labels.

1. Prefinished items not to be painted include all factory-finished components such as:

a. Prefinished metal fabrications.
b. Acoustic ceilings.
c. Joinery and architectural woodwork.
d. Elevator equipment.
e. Finished mechanical and electrical equipment.
f. Light fixtures.
g. Switchgear.
h. Distribution cabinets.

2. Finished metal surfaces not to be painted include:

    a. Anodized aluminum.
    b. Stainless steel.
    c. Chromium plate.

3. Operating parts not to be painted include moving parts of operating equipment such as the following:

    a. Valve and damper operators.
    b. Linkages.
    c. Sensing devices.
    d. Motor and fan shafts.

4. Labels: Do not paint over regulation or code-required labels or equipment name, identification, performance rating, or nomenclature plates.

DEFINITIONS

A. "Paint" includes coating systems materials; primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate, or finish coats.

QUALITY ASSURANCE

A. Single-Source Responsibility: Provide primers and undercoat paint produced by the same manufacturer as the finish coats.

B. Coordination of Work: Review other sections in which primers are provided to ensure compatibility of the total systems for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.

PART 2 - PRODUCTS

MATERIALS, GENERAL

A. Material Quality: Provide only best quality grades low VOC (Volatile Organic Compounds) content for the various types of coatings and paint systems required, as regularly manufactured and recommended by acceptable paint manufacturers. Paint material containers not displaying manufacturer's names and product identification will not be acceptable.

    1. Proprietary names used to designate colours or materials are not intended to imply that products of named manufacturers are required or to exclude equivalent products of other manufacturers.

B. Colour Pigments: Pure, non-fading, applicable types to suit substrates and services indicated.

    1. Lead contents in pigment, if any, is limited to contain not more than 0.06% lead, as lead metal based on the total non-volatile (dry-film) of paint be weight.

FIELD QUALITY CONTROL

A. The Engineer reserves the right to request the following test procedure at any time and as often as the Engineer deems necessary during the period when paint is being applied:

1. The Contractor shall engage the services of an independent testing laboratory approved by the Engineer to sample the paint material being used. Samples of material delivered to the project will be taken, identified, sealed, and certified in the presence of the Contractor.

2. The testing laboratory will perform appropriate tests for all or any of the following characteristics as required by the Engineer:

    a. Quantitative materials analysis.
    b. Abrasion resistance.
    c. Apparent reflectivity.
    d. Flexibility.
    e. Wash ability.
    f. Absorption.
    g. Accelerated weathering.
    h. Dry opacity.
    i. Accelerated yellowness.
    j. Recoating.
    k. Skinning.
    l. Color retention.
    m. Alkali and mildew resistance.

3. If test results show material being used does not comply with specified requirements, the Contractor may be directed to stop painting, remove noncomplying paint from the site and repaint surfaces coated with rejected paint, and remove rejected paint from previously painted surfaces if, upon repainting with specified paint, the two coatings are noncompatible.

PART 3 - EXECUTION

EXAMINATION

A. Examine substrates, areas, and conditions under which painting will be performed for compliance with paint application requirements. Do not begin to apply paint until unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.

PREPARATION

A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of the size or weight of the item, provide surface-applied protection before surface preparation and painting.

    1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

B. Cleaning: Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the various coatings. Remove oil and grease before cleaning.

    1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

C. Surface Preparation: Clean/prepare surfaces according to manufacturer's written instructions for each particular substrate condition to be painted.

D. Materials Preparation: Mix/prepare paint materials according to manufacturer's written instructions.

1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
3. Use only thinners approved by paint manufacturer and only within recommended limits.

E. Tinting: Tint each undercoat a lighter shade to simplify identification of each coat when multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

APPLICATION

A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
1. Surface treatments and paint finishes are indicated in the schedules.
2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
3. Provide finish coats that are compatible with primers used.
4. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
5. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.
6. Sand lightly between each succeeding enamel or varnish coat.

B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

1. The number of coats and the film thickness required are the same regardless of application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions sand between applications.
2. Omit primer on metal surfaces that have been shop primed and touchup painted.
3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion.

C. Application Procedures: Apply paints and coatings by brush, roller, or other applicators according to manufacturer's written instructions.

1. Brushes: Use brushes best suited for the type of material applied. Use brush of appropriate size for the surface or item being painted.

2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.

D. Minimum Coating Thickness: Apply paint no thinner than manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.

E. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed in equipment rooms and in occupied spaces.

F. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by the manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to

ensure a finish coat with no burn through or other defects due to insufficient sealing.

G. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

CLEANING

A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from the site.

1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces.

PROTECTION

A. Protect work of other trades, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Engineer.

B. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.

1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

PART 4 - PAINT SCHEDULES

EXTERIOR PAINT SCHEDULE

A. General: Provide the following paint systems for the various substrates indicated.

B. Ferrous Metal: Primer is not required on shop-primed items.

1. Full-Gloss Alkyd Enamel: 2 finish coats over primer.

a. Primer: Synthetic Rust-Inhibiting Primer.
b. First and Second Coats: Alkyd Gloss Enamel.

2. Lusterless Alkyd Enamel: 2 finish coats over primer.

a. Primer: Synthetic Rust-Inhibiting Primer.
b. First and Second Coats: Lusterless Alkyd Enamel.

C. Zinc-Coated Metal:

1. Full-Gloss Alkyd Enamel: 2 finish coats over primer.

a. Primer: Galvanized Metal Primer.
b. First and Second Coats: Alkyd Gloss Enamel.

INTERIOR PAINT SCHEDULE

A. General: Provide the following paint systems for the various substrates, as indicated.

B. Concrete and Plasters.

1. Lusterless (Flat) Emulsion Finish: 3 coats.

    a. Primer: Latex-Based Interior Flat Paint.
    b. Under Coat: Latex-Based Interior Flat Paint.
    c. Finish Coat: Latex-Based Interior Flat Paint.

2. Odorless Lusterless (Flat) Latex Finish: 3 coats.

    a. Primer: Latex-Based Interior Flat Paint.
    b. First Coat: Latex-Based Interior Flat Paint.
    c. Second Coat: Interior Flat Odorless Alkyd Paint.

3. Semigloss Enamel Finish: 3 coats with total dry film thickness not less than: 0.09 mm, on concrete, 0.06mm on plaster.

    a. Primer: Latex-Based Interior Flat Paint.
    b. Undercoat: Interior Enamel Undercoat.
    c. Finish Coat: Interior Semigloss Odorless Alkyd Enamel.

4. Plastic Coating Finish: Multiple coating system including preparation sealer, primer and undercoats; applied in strict accordance with manufacturer recommendations and instructions for substrate and purpose of use.

    a. Purpose : Provision of a heavy duty washable, monolithic and anti-bacterial surface finish to cement plastered walls and ceilings in hospital rooms and areas requiring a high degree of cleanliness and hygiene.
    b. Available Products: subject to compliance with requirements, products which may be incorporated, in the work include, but are not limited to:

C. Concrete Masonry Units:

1. Lusterless (Flat) Emulsion Finish: 2 finish coats over filled surface.
    a. Latex Block Filler.
    b. First and Second Coats: Latex-Based Interior Flat Paint.

2. Semigloss Alkyd Enamel Finish: 2 coats over filled surface with total dry film thickness not less than 0.09 mm, excluding filler coat.

    a. Latex Block Filler.
    b. Undercoat: Interior Enamel Undercoat.

    c. Finish Coat: Interior Semigloss Odorless Alkyd Enamel.

D. Painted Wood and Hardboard:

1. Semigloss Enamel Finish: 3 coats.

    a. Undercoat: Interior Enamel Undercoat .
    b. First and Second Coats: Interior Semigloss Odorless Alkyd Enamel .

2. Full-Gloss Enamel Finish: 3 coats.

    a. Undercoat: Interior Enamel Undercoat .
    b. First and Second Coats: Alkyd Gloss Enamel.

E. Ferrous Metal:

1. Lusterless (Flat) Finish: 3 finish coats over primer with total dry film thickness not less than 0.06 mm.
    a. Primer: Synthetic Rust-Inhibiting Primer.
    b. First and Second Coats: Latex-Based Interior Flat Paint.

2. Semigloss Enamel Finish: 2 coats over primer with total dry film thickness not less than 0.06 mm.

    a. Primer: Synthetic Rust-Inhibiting Primer.
    b. Undercoat: Interior Enamel Undercoat.
    c. Finish Coat: Interior Semigloss Odorless Alkyd Enamel.

F. Zinc-Coated Metal:

1. Lusterless (Flat) Finish: 2 finish coats over primer with total dry film thickness not less than 0.06 mm.

    a. Primer: Galvanized Metal Primer.
    b. First and Second Coats: Latex-Based Interior Flat Paint.

2. Semigloss Finish: 2 coats over primer, with total dry film thickness not less than 0.06 mm.

    a. Primer: Galvanized Metal Primer.
    b. Undercoat: Interior Enamel Undercoat.
    c. Finish Coat: Interior Semigloss Odorless Alkyd Enamel.

3. Full-Gloss Enamel Finish: 2 Coats over primer with total dry film thickness not less than 0.06mm.

    a. Primer: Galvanized Metal Primer.
    b. Undercoat: Interior Enamel Undercoat.
    c. Finish Coat: Alkyd Gloss Enamel.

CHAPTER TEN
SPECIALTIES

10.1 Toilet Accessories

PART 1 - GENERAL

DESCRIPTION OF WORK

A. Furnish and install the following toilet accessory items as indicated on Drawings and/or required by Engineer:
   1. Toilet roll lockers.
   2. Soap holders and soap box.
   3. Paper holder.
   4. Mirror units.

   All as indicated in details on drawings.

PART 2 - PRODUCT

As stated on drawings.

PART 3 - EXECUTION

INSTALLATION

A. Install toilet accessory and mirror units in accordance with manufacturer's instructions, using purpose concealed fasteners appropriate to substrate and recommended by manufacturer of unit. Install units plumb, level and square, firmly anchored in locations and at heights indicated.
   1. Mirrors: Provide plywood backing panels, filters and other ancillaries as indicated and required.

ADJUSTING AND CLEANING

A. Adjust toilet accessories for proper operation and verify that mechanisms functions smoothly. Replace damaged or defective items.

B. Clean and polish all exposed surface not more than 4 days prior to date scheduled for inspections intended to establish date for substantial completion, in strict accordance with manufacturer's recommendations after removing temporary labels and protective coatings.

10.2 CLASSROOM SPECIALTIES

10.2.1 WHITE TEACHING BOARD AND TALKBOARDS

10.2.1.1 Description

A. General

1. Furnish all labor, materials, tools, equipment, and services for all white boards and tackboards, in accord with provisions of Contract Documents.
2. Completely coordinate with work of other trades.
3. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.
4. See Division 1 for General Requirements.
5. Unless otherwise approved, furnish all white boards and tackboards by one manufacturer.

10.2.1.2 Submittals

A. Samples:

1. 400 x 600 mm samples of sheet materials. Colors and textures of materials shall match Color Schedule and Color Palette.

10.2.1.3 Product Delivery, Storage and Handling

A. Deliver boards completely assembled whenever possible. Where dimensions exceed available panel size, provide 2 or more pieces of length acceptable to Architect. When dimensions require delivery in separate units. Profit at factory, disassemble for delivery, and make final joint at site.

B. Perform all required unpacking at site.

1. Furnish all labor, materials, tools, equipment, and services for all white boards and tackboards, in accord with provisions of Contract Documents.

10.2.2 PRODUCTS

10.2.2.1 Materials

A. White Writing Board.
1. Top quality white writing board for felt Marker Pends.
2. Surface shall be made of highly durable Porcelain board, conform to the International quality standard, with lifetime warranty.
3. No maintenance shall be required through all years of use.
4. The boards surface shall be resistant to stain, ghost, scratch, and dent, and it shall be magnetic, washable, acid resistant and resistant to any other type of cleaning material.
5. Each board is labeled with the factory warranty for intensive use.
6. Anodized-aluminum frame with round corner or with round plastic end.
7. Internal structure of the board to be Honeycomb panel in high density board minimum 8 mm thick or equivalent.
8. At top aluminum Map – holder profile or magnetic holding tools.
9. At bottom an aluminum long tray for holding writing and erasing materials.
10. The white (Porcelain) boards can also be used as overhead projection screen.
11. Galvanized protected backside against wall humidity.
12. Dimensions: minimum 3600 mm x 1200 mm with allowed tolerance of 50 mm in height and in width. (Final dimensions as per site limitation).

B. Tackboards, vinyl-fabric-faced: Vinyl fabric complying with F.S. CCC-W-408, Type II, Class 2, laminated to 6mm (1/4 IN) thick cork backing sheet ASTM C640.

1. Laminate under pressure to 6 mm (1/4 IN) thick treated plywood or hardboard backing.

C. Felt marker pens and erasers: for each chalkboard on the project, provide 12 felt marker pens (6 black, 3 red and 3 green), and 2 pens erasers, all as recommended by white board manufacturer.

10.2.3 EXECUTION

10.2.3.1 Inspection

A. Examine substrates and conditions under which work is to be performed.

B. Correct unsatisfactory Conditions.

C. Installation Constitutes acceptance of responsibility for performance.

10.2.3.2 Installation

A. Unless otherwise indicated, provide factory-built units.

B. Treat vertical joints in white board as follows:

1. Steel board units: Use extended aluminum H-type divider bars.

C. Provide additional backing as indicated or necessary to properly stiffen and support boards.

D. Install at locations and heights indicated in accord with manufacturer's instructions.

E. Install with concealed hangers, plumb and level.

F. Coordinate job-assembled units with grounds, trim, and accessories. Join all parts with neat, precision fit.

G. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations.

10.3 EPOXY RESIN WORK

PART 1 - GENERAL

Countertops, drinking basin and curbs are molded from a modified epoxy resin that has been especially compounded and cured to provide optimum physical and chemical resistance required for a heavy duty working surface. They are a uniform mixture throughout, and do not depend on a surface coating that can be readily removed by chemical or physical abuse. Tops have a thickness required with a drip groove provided on underside of all sink top exposed edges. All edges shall have a slight radius. Curbs are bonded to the surface on the top to form a square water-tight joint. All joints in tops are bonded with an approved epoxy cement and shall be smooth and water-tight. Counters with integral curbs have a junction with a ¾" radius, except around columns and special cutouts, which will have a standard bonded curb.

PART 2 – PRODUCTS

2.1 SOLID SURFACE SHEET MATERIAL

A. Composition: Acrylic resins, fire-retardant mineral fillers, and proprietary coloring agents. Through-the-body color for full thickness of sheet material.

B. Material Thickness: 1/2 inch, nominal.

C. Color, Pattern, and Finish Design: Selected from manufacturer's standard offerings.

D. Edge Detail: Selected from manufacturer's standard offerings.

2.2 ACCESSORY MATERIALS

A. Joint Adhesive: Methacrylate-based adhesive for chemically bonding solid surfacing seams. Color complementary to solid surfacing sheet material.

B. Elastomeric Sealant: Mildew-resistant silicone sealant for filling gaps between countertops and terminating substrates in wet environment applications.

C. Siliconized Acrylic Sealant: Siliconized acrylic latex sealant. For general applications to fill gaps between countertops and at terminating substrates.

D. Construction Adhesive: Countertop manufacturer's recommended silicone-based construction adhesive for backsplashes, endsplashes, and other applications according to manufacturer's published fabrication instructions.

2.3 FABRICATION

A. Fabricate components in shop, to greatest extent practicable, in sizes and shapes indicated according to approved shop drawings.

B. Form joint seams between solid surfacing components with specified seam adhesive. Completed joints inconspicuous in appearance and without voids. Provide joint reinforced if required by manufacturer for particular installation conditions.

C. Provide holes and cutouts indicated on approved shop drawings. Rout cutouts and complete by sanding all edges smooth.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions that could adversely affect the work of this Section.

B. Substrates must be sound, flat, smooth, and free from dust or other surface contaminants.

C. Commencement of work will constitute acceptance of substrates and conditions to receive the work.

3.2 COUNTERTOP WITH SINK, DRINKING BASIN INSTALLATION

A. Install solid surfacing components plumb, level, and true according to approved shop drawings and manufacturer's published installation instructions. Use steel working and specialized fabrication tools acceptable to manufacturer.

B. Form joint seams with specified seam adhesive. Seams to be inconspicuous in completed work. Seams in locations shown on approved shop drawings and acceptable to manufacturer. Promptly remove excess adhesive.

C. Provide minimum 1/2 inch radius for countertop / drinking basin inside corners.

D. Fill gaps between countertop / drinking basin and terminating substrates with specified silicone sealant.

E. Back splashes are manufactured as one piece with countertop / drinking basin as shown on drawings and approved by Engineer.

F. Vanities are manufactured as one piece with counter top as shown on drawings and approved by Engineer.

10.4 ROUND CORNER PROTECTOR ON ALUMINUM CORE

DESCRIPTION

90° round corner protector mounted on aluminum core comprising 2.5 mm thick smooth and antibacterial PVC profile achieving Bs2d0 fire rating with solid colour. A protective film is specified to minimize cleaning before acceptance. Wings are 45 mm wide (internal measurement) and snap-fix to a continuous pre-drilled aluminum core. The corner protector is finished with a smooth PVC endcap.

ENVIRONMENT

No heavy metals are used in its formulation, including lead or tin (insignificant levels, less than 50 ppm) or any CMR Cat. 1 or 2 substances. The calcium-zinc thermal stabilization process is used. The emission level of volatile substance in inside air has been tested according to ISO 16000 and is very low (A+). 100% of the product are recyclable.

COLOUR

Selected by Architects from manufacturer's standard range.

INSTALLATION METHOD

Snap-fixes to continuous pre-drilled aluminum core screwed to wall.

10.5 INTERNAL CURTAINS

GENERAL

Furnish all labor, materials, tools, equipment, and services for internal curtains in accordance with provisions of Contract Documents.

QUALITY ASSURANCE

A. Source of Materials: Provide materials obtained from one source acceptable to Engineer for type and colour of internal curtains and setting materials.

SUBMITTALS:

A. Product data:
   1. Manufacturer's literature for internal curtains and installation materials.
   2. Manufacturer's instructions for installation.

B. Samples:
   1. Samples of colors of internal curtains.

C. Project data:
   1. Certification of applicator qualifications. The applicator should be qualified.

EQUIPMENT

A. ROLLER TUBE

The fabric rolls around the metal tube which supports the weight of the shade, is not to be exposed even when the shade is fully lowered.

B. END PLUG

The end plug or rotator to be fit into the installation bracket.

C. FABRIC

Design and colour to be approved by the Engineer.

D. BOTTOM OF CURTAIN

Add bottom rod and end cap to curtain to hold the fabric in position and add weight to the shade.

E. CLUTCH

Provide clutch to curtain to rotate the roller tube to raise or lower the shade.

F. CURTAIN CORD

Provide necessary cord items:
- Beaded cord for continuous loop.
- Beaded cord connector to attach the two ends of the beaded cord.
- Cord tensioner for enhanced child safety.

CHAPTER ELEVEN

DRINKING WATER

11.1 LEBANESE STANDARD

مواصفة لبنانية

NORME LIBANAISE

LEBANESE STANDARD

NL

161:2016

Deuxième édition
Second Edition
2016

مياه الشرب

EAU POTABLE

DRINKING WATER

مؤسسة المقاييس والمواصفات اللبنانية
--------LIBNOR--------

Numéro de référence
Reference Number
NL 161 (A)
ICS: 13.060.20

مؤسسة المقاييس والمواصفات اللبنانية - ليبنور هي مؤسسة عامة ترتبط بوزارة الصناعة. أنشأت بموجب قانون صادر بتاريخ 23 تموز 1962 تتولى بموجبه "وحدها وضع المقاييس والمواصفات الوطنية ونشرها وتعديلها ومنح حق استعمال شارة المطابقة للمقاييس والمواصفات.

توضع المواصفات والمقاييس وتناقش وتصاغ في لجان فنية اختصاصية تؤلفها المؤسسة لهذا الغرض.

تتناول المقاييس والمواصفات الوطنية – على سبيل المثال لا الحصر – القياسات والمصطلحات والرموز وتحديد النوعية للمنتجات والسلع وطرق الفحص والتحليل والاختبار وأصول العمليات المهنية وقواعد الانشاءات الفنية".

"المقاييس والمواصفات اللبنانية التي تقرها المؤسسة اختيارية مبدئياً، ولكن لاعتبارات تتعلق بالسلامة العامة أو الصحة العامة أو المصلحة الوطنية، يمكن للحكومة أن تعطي لأي من المقاييس والمواصفات اللبنانية صفة الإلزام القانوني بموجب مرسوم يتخذ في مجلس الوزراء".

تشارك ليبنور في أعمال التقييس الدولية من خلال عضويتها وانتسابها إلى المنظمة الدولية للتقييس (**ISO**) واللجنة الأوروبية للتقييس (**CEN**) والمنظمة العربية للتنمية الصناعية والتعدين (**AIDMO**) ولجنة الدستور الغذائي (**CODEX Alimentarius**).

مؤسسة المقاييس والمواصفات اللبنانية
سن الفيل، شارع سيتي راما، بناية ليبنور
ص.ب.: 55120 سن الفيل، لبنان
هاتف: 927 485 1 961 +
فاكس: 929 485 1 961 +
Website: www.libnor.gov.lb
E-mail: info@libnor.org

ليبنور

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ليبنور

تمهيـــد

أعدت هذه المواصفة القياسية "مياه الشرب"، رقم 161:2016، وفقًا لإجراءات ليبنور الداخلية، وكانت لجنة "جودة المياه NL TC 147" في مؤسسة المقاييس والمواصفات اللبنانية هي المسؤولة عن إعدادها.
واعتمدت اللجنة الفنية في إعداد هذه المواصفة بشكل أساسي على الدراسة التي أعدتها منظمة الصحة العالمية والتي إستندت فيها على:

- Guidelines for Drinking-Water Quality – Fourth Edition – World Health Organization 2011.
- National Primary Drinking Water Regulations (NPDWRs) – Table of contaminants – US Environmental Protection Agency (EPA)

تلغي هذه المواصفة القياسية المواصفة القياسية اللبنانية التالية: NL 161:1999
وافقت اللجنة الفنية على هذه المواصفة في اجتماعها بتاريخ 2016/8/2.
أقر مجلس إدارة المؤسسة هذه المواصفة في اجتماعه بتاريخ 2016/10/28.
تجدر الإشارة الى أن الملحقات الإعلامية المرفقة بهذه المواصفة غير ملزمة.

ليبنور

اللجنة الفنية

المنسق:	الجهة:
سحر الحاج سليمان	مؤسسة المقاييس والمواصفات اللبنانية - ليبنور
الأعضاء:	
مايا أسعد	وزارة الصحة العامة
مايا سرور	وزارة الطاقة والمياه
ميرفت كريدية	وزارة الطاقة والمياه
م. لينا عاصي	وزارة الصناعة
م. منى عساف	وزارة الزراعة
د. سابين بركات	وزارة البيئة
م. تانيا أبي الحسن	وزارة الإقتصاد والتجارة
م. كارول أبي نادر	وزارة الإقتصاد والتجارة - Qualeb
د. بولس سعيد	مؤسسة مياه بيروت وجبل لبنان
سليمان الجمال	مؤسسة مياه البقاع
أمل الشدياق	مؤسسة مياه لبنان الجنوبي
فائزة السنكري	مؤسسة مياه لبنان الشمالي
نوال الذهب	مؤسسة مياه لبنان الشمالي
د. رولى بو خزام	الهيئة اللبنانية للطاقة الذرية – المجلس الوطني للبحوث العلمية
سيلين حجار	مصلحة الأبحاث العلمية الزراعية
م. هوفيك قيومجيان	معهد البحوث الصناعية

ليبنور

د. كارول السخن	مختبر البيئة المركزي – الجامعة الأميركية في بيروت
م. علي برو	نقابة المهندسين في بيروت
نهال الحمصي	منظمة الصحة العالمية
كارين صباغ	شركة ريم للمياه المعدنية الطبيعية
م. مشلين الصياح	Fluid Design sal & Watermaster sal

مياه الشرب

1. المجال

تختص هذه المواصفة القياسية بمياه الشرب غير المعبأة المعدة للإستهلاك البشري.

2. تعاريف

1.2- مياه الشرب غير المعبأة (مياه الشفة): مياه صالحة للاستهلاك البشري، وتنطبق عليها جميع الخصائص المميزة لها والواردة في هذه المواصفة القياسية.

2.2- المياه السطحية: المياه الجارية في الأنهار والسيول أو مياه البحيرات أو السدود أو البرك أو التجمعات المائية الأخرى.

3.2- المياه الجوفية المحمية: المياه المتواجدة تحت سطح الأرض وغير المعرضة للتلوث والتي تقع ضمن حريم البئر.

4.2- حريم البئر يعني حقوقه من جهاته من كل طرف أربعون ذراعا.

5.2- المياه الجوفية غير المحمية: المياه المتواجدة تحت سطح الأرض والمعرضة للتلوث.

3. المتطلبات والخصائص

يجب أن يتوافر في مياه الشرب ما يلي:

1.3. الخصائص الحسية والفيزيقية

يجب ألا تزيد الخصائص الحسية والفيزيقية لمياه الشرب على الحدود الواردة في الجدول رقم (1) أدناه:

الجدول رقم (1): الحد الاقصى للخصائص الحسية والفيزيقية في مياه الشرب

الخصائص الحسية والفيزيقية	الحد الاقصى المسموح به	وتيرة أخذ العينات لمصادر المياه السطحية، والجوفية المحمية وغير المحمية
الطعم	مقبول لدى المستهلك	يتم تحليل هذه الخصائص عند أخذ أي عينة
الرائحة	مقبول لدى المستهلك	
اللون	أقل من 15 Pt-Co	

الموصلية عند حرارة 20 درجة سْ	200-1500 µS/cm	يتم تحليل هذه الخصائص عند أخذ أي عينة
تركيز شوارد الهدرجين	6.5-8.5	
العكارة	أقل من 5 NTU أو أقل من 5 FTU	
المواد الصلبة الحلولة	100-750 mg/l	
القساوة الإجمالية محتسبة بكربونات الجير (الناتجة عن الكالسيوم والمغنيزيوم)	500 mg/l	يتم أخذ العينات وتحليلها مرة كل ستة أشهر وعند الضرورة
الكلسيوم محتسباً ككربونات الجير ($CaCO_3$)	300 mg/l	
المغنيزيوم محتسبا ككربونات المغنيزيوم ($MgCO_3$)	200 mg/l	

2.3. الخصائص الكيميائية

يجب أن تتوافق الخصائص الكيميائية لمياه الشرب مع المتطلبات الواردة في الجداول رقم (2) و(3) و(4) و(5) و(6) الواردة أدناه:

الجدول رقم (2): المواد الكيميائيّة المتوفّرة طبيعيًّا في الماء

المادة الكيميائية	الحد الأقصى المسموح به	وتيرة أخذ العينات لمصادر المياه السطحية، والجوفية المحمية وغير المحمية
صوديوم Sodium (Na)	200 mg/l	يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة
كلوريد Chloride (Cl^-)	250 mg/l	
فلوريد Fluoride (F^-)	1.5 mg/l (temp 8-18°C) 0.7 mg/l (temp 25-30°C)	
باريوم Barium (Ba)	0.7 mg/l	
الزرنيخ Arsenic	0.01 mg/l	

يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة	0.5 mg/l	الحديد Iron (Fe)
	0.1 mg/l	المنغنيز Manganese (Mn)
	2.4 mg/l	بورون Boron (B)
	0.003 mg/l	كادميوم Cadmium (Cd)
	0.05 mg/l	الكروم الاجمالي (الكروم سداسي التكافؤ) Total Chromium (Cr) (Hexavalent Chromium Cr VI)
	0.07 mg/l	موليبدينوم Molybdenum (Mo)
	0.04mg/l	سلينيوم Selenium (Se)
	0.03mg/l	يورانيوم Uranium (U)
	0.35 – 0.5 mg/l	خامس أكسيد الفسفور Phosphate (P_2O_5)

الجدول رقم (3): المواد الكيميائية المتوفّرة في المياه الناتجة من مصادر صناعية والمساكن البشرية

المادة الكيميائية	الحد الأقصى المسموح به	وتيرة أخذ العينات لمصادر المياه السطحية، والجوفية المحمية وغير المحمية
Mercury (Hg)	0.006 mg/l	يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة
Cyanide (CN)	0.05 mg/l	
Hexachlorobutadiene	0.6 µg/l	
Pentachlorophenol	0.009 mg/l	
Nitrilotriacetic acid	0.2 mg/l	
1,4 Dioxane	0.05 mg/l	
Di(2-Ethylhexy) phthalate	0.008mg/l	
Dichloromethane	0.02 mg/l	
1,2 dichloromethane	0.03 mg/l	
1,2 Dichloroethene	0.05 mg/l	
Trichloroethene	0.02 mg/l	
Tetrachloroethene	0.04 mg/l	

يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة	1 mg/l	1,2 Dichlorobenzene
	0.3 mg/l	1,4 Dichlorobenzene
	0.3mg/l	Ethyl benzene
	0.02 mg/l	Trichlorobenzene
	1 µg/l	Hexachlorobenzene
	0.004 mg/l	Carbon tetrachloride
	0.3 mg/l	Methyl tertiarybutyl ether
	0.7 mg/l	Toluene
	0.5 mg/l	Xylene
	0.02 mg/l	Styrene
	0.01 mg/l	Benzene
مرة شهريا وعند الضرورة	< 2 mg/l for TOC	Total organic carbon (TOC) or equivalent tests

الجدول رقم (4): المواد الكيميائية الناتجة عن النشاطات الزراعية

وتيرة أخذ العينات لمصادر المياه السطحية، والجوفية المحمية وغير المحمية	الحد الأقصى المسموح به	المادة الكيميائية
يتم تحليل هذه الخصائص عند أخذ أي عينة	0.5 mg/l	Ammonia (NH_3)
	45 mg/l	Nitrates (NO_3^-)
	0.05 mg/l	Nitrites (NO_2^-)
يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة	0.01mg/l	Aldicarb
	0.007mg/l	Carbofuran
	0.6 µg/l	Endrin
	0.03 µg/l	Heptachlor and Heptachlorepoxide
	0.002 mg/l	Lindane
	0.02 mg/l	Metoxychlor
	0.2 µg/l	Chlordane

يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة	0.03 µg/l	Aldrin+Dieldrin
	0.03 mg/l	2,4 – Dichlorophenoxyacetic acid
	0.009 mg/l	2,4,5 – Trichlorophenoxyacetic acid
	0.02 mg/l	Alachlor
	0.1 mg/l	Atrazine and its metabolites
	300 µg/l	Bentazone
	0.6 µg/l	Cyanazine
	0.009 mg/l	Isoproturon
	0.002 mg/l	MCPA [4 – (2 – Methyl – 4 – chlorophenoxy) acetic acid]
	0.01 mg/l	Mecoprop
	0.006 mg/l	Molinate
	0.02 mg/l	Pendimethalin
	0.3 mg/l	Permethrin
	0.002 mg/l	Simazine
	0.02 mg/l	Trifluralin
	0.01 mg/l	Metolachlor
	0.006 mg/l	Dimethoate
	0.4 µg/l	1,2Dibromoethane
	0.04 mg/l	1,2 Dichloropropane
	0.001 mg/l	1,2 dibromo-3chloropropane
	0.02 mg/l	1,3 Dichloropropene
	10 ng/l	Nitrosamimes

الجدول رقم (5): بقايا المبيدات لأغراض الصحة العامة

وتيرة أخذ العينات لمصادر المياه السطحية، والجوفية المحمية وغير المحمية	الحد الأقصى المسموح به	المادة الكيميائية
يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة	0.001 mg/l	DDT + Metabolites

الجدول رقم (6): المواد الكيميائية المستخدمة في معالجة الماء أو في المواد الملامسة لمياه الشرب

المواد الكيميائية المستخدمة في معالجة الماء أو في المواد الملامسة لمياه الشرب		
منتجات التطهير الثانوية	**الحد الأقصى المسموح به**	**وتيرة أخذ العينات لمصادر المياه السطحية، والجوفية المحمية وغير المحمية**
الكلور الحرّ (Free chlorine)	للتطهير بشكل فعال، يجب أن لا تقلّ نسبة الكلور المتبقي الحر عن 0.5 مغ/لتر بعد 30 دقيقة على الأقلّ من ملامسة المادة للماء في ظلّ رقم هدروجيني يتراوح بين 6.5 و8.5. ويجب أن لا تقل النسبة المتبقية من الكلور الحر في نظام التوزيع كلّه وفي نقطة التسليم (عند المستهلك) عن 0.2 مغ/لتر، كما يجب أن لا تزيد عن 0.5 مغ/لتر.	يتم تحليل هذه الخصائص عند أخذ أي عينة
Monochloramine	0.5 – 1.5 mg/l	يتم تحليل هذه الخصائص عند أخذ أي عينة
Chlorite	0.7 mg/l	يتم أخذ العينات وتحليلها إذا تمت المعالجة بثاني أوكسيد الكلور ClO2
Chlorates	0.7 mg/l	يتم أخذ العينات وتحليلها إذا تمت المعالجة بثاني أوكسيد الكلور ClO2
Bromates	0.01 mg/l	يتم أخذ العينات وتحليلها مرة كل ستة أشهر وعند الضرورة
Chloroform	0.3 mg/l	
Bromoform	0.1 mg/l	
Bromodichloromethane	0.06 mg/l	
Dibromochloromethane	0.1 mg/l	

الأسيتونتريلات المهلجنة Halogenated Acetonitriles Dichloroacetonitrile Dibromoacetonitrile	0.02mg/l 0.07mg/l	يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة
Sum of Haloacetic acids	0.06 mg/l	يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة
2,4,6 – Trichlorophenol	0.2 mg/l	يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة

ملوثات من مواد كيميائية مستخدمة في المعالجة	الحد الأقصى المسموح به	وتيرة أخذ العينات لمصادر المياه السطحية، والجوفية المحمية وغير المحمية
Acrylamide	0.5 µg/l	يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة
Aluminum (Al)	0.2 mg/l	
Epichlorohydrin	0.4µg/l	

ملوثات من الأنابيب والتوصيلات	الحد الأقصى المسموح به	وتيرة أخذ العينات لنظام التوزيع والشبكات
Antimony (Sb)	0.02 mg/l	يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة
Polynuclear aromatic hydrocarbons (the sum) (benzo[a]pyrene)	0.7 µg/l	يتم أخذ العينات وتحليلها مرة كل ستة أشهر وعند الضرورة
Copper (Cu)	1 mg/l	يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة
Lead (Pb)	0.01 mg/l	
Nickel (Ni)	0.07 mg/l	
Vinyl chloride	µg/l 0.3	

3.3الخصائص الشعاعية

يجب أن يكون الحد المرجعي للخصائص الشعاعية كما هو وارد في الجدول رقم (7) أدناه:

الجدول رقم (7): الحد الأقصى للخصائص الشعاعية في مياه الشرب

الخصائص الشعاعية	الحد الأقصى المسموح به	وتيرة أخذ العينات لمصادر المياه السطحية، والجوفية المحمية وغير المحمية
النشاط الإشعاعي ألفا الإجمالي Gross Alpha Activity	0.5 Bq*/l	يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة
النشاط الإشعاعي بيتا الإجمالي Gross Beta Activity	1 Bq/l	

* 1 بيكريل (becquerel – Bq) = 1 انحلال في الثانية الواحدة

ملاحظة: إنّ قيمتي 0.1 بيكريل/لتر للنشاط الاشعاعي ألفا الإجمالي و1 بيكريل/لتر للنشاط الاشعاعي بيتا الإجمالي ما زال يوصى بهما كمستويين للكشف في مياه الشرب حيث لا حاجة إلى اتخاذ أي إجراء إذا كانت النتائج أدنى منهما. أمّا إذا تمّ تخطّي مستويات الكشف، يجب عندئذ فحص تركيز النويدات المشعّة الفرديّة ومقارنتها بالمستويات المحدّدة الموصى بها. (تمّ ذكرها في الملحق رقم (5)).

4.3لخصائص الحيوية

يجب ان تكون مياه الشرب خلوا من الفيروسات (تم ذكرها في الملحق رقم 4) وخلواً من الحشرات او بويضاتها او يرقاتها او حويصلاتها او اجزائها او الحيوانات الاولية (تم ذكرها في الملحق رقم 4) ومن ضمنها الاميبا، وان تكون خلواً من الطحالب والفطريات.

5.3الخصائص الجرثومية

يجب ألا تزيد الخصائص الجرثومية في مياه الشرب على الحدود الواردة في الجدول رقم (8) أدناه:

الجدول رقم (8): الحد الأقصى للخصائص الجرثومية في مياه الشرب

الخصائص الجرثومية	الحد الأقصى المسموح به	وتيرة أخذ العينات
قولونيات إجمالية Total Coliforms	< 1 CFU in 100 ml	يتم أخذ العينات وفقا للجدول رقم (9)
قولونيات متحملة للحرارة Thermotolerant Coliforms	< 1 CFU in 100 ml	
مكورات معويّة		

Intestinal Enterococci	< 1 CFU in 100 ml	
بسودوموناس ايروجينوزا Pseudomonas Aeruginosa	< 1 CFU in 100 ml	

4.طرق أخذ العينات للفحص الجرثومي

تؤخذ عينات الفحص الجرثومي من مصادر وشبكات توزيع المياه وفقا للجدول رقم (9):

الجدول رقم (9): وتيرة أخذ عينات مياه الشرب للفحص الجرثومي (بالمتر المكعب يوميا")

مصدر مياه الشرب	وتيرة أخذ العينات للفحص الجرثومي
كمية المصادر الجوفية المحمية	عينة / الشهر
كمية المصادر السطحية بالمتر المكعب: تستثمر أقل من 000 5 م3 / اليوم تستثمر من 5000 حتّى 000 100 م3 / اليوم تستثمر أكثر من 000 100 م3 / اليوم	 عينة / الشهر عينتين /الشهر بفارق أسبوعين عينة /الأسبوع
كمية المصادر الجوفية غير المحمية بالمتر المكعب:	عينتين / الشهر
المصادر الرئيسية: تستثمر من 2000 حتّى 4000 م3 / اليوم تستثمر أكثر من 5000 م3 / اليوم	عينة / الأسبوع
المصادر الفرعية: تستثمر أقل من 2000 م3 / اليوم	 عينة / الشهر
كمية الشبكة المائية ، نظام التوزيع (محطات الضخ، الخزانات العامة-الشبكات) :	عيّنة من الخزان /الشهر 3 عينات من الشبكة / الشهر
تستثمر أقل من 000 5 م3 / اليوم	
تستثمر من 000 5 حتّى 000 100 م3 /اليوم	عينة من الخزان /الأسبوع 3 عينات من الشبكة / الشهر / 000 5 م3 /اليوم
تستثمر من 000 100 م3 / اليوم حتّى 000 500 م3 / اليوم	2 عينة من الخزان /الأسبوع 3 عينة من الشبكة / الشهر /000 10 م3 /اليوم

ليبنور

5.طرق الاختبار

تعتمد طرق الإختبار المعروفة والمناسبة والمثبتة عالميا والصادرة عن المنظمات العالمية التالية:

- APHA: The American Public Health Association
- AOAC International
- EPA: U.S. Environmental Protection Agency
- FDA: U.S. Food and Drug Administration
- ISO: International Organization for Standardization

6.مراجع البحث

- Guidelines for Drinking-Water Quality – Fourth Edition – World Health Organisation 2011.
- National Primary Drinking Water Regulations (NPDWRs) – Table of contaminants - US Environmental Protection Agency (EPA)

الملحق رقم (1)

(إعلامي)

الملوثات الناتجة عن عوامل حيوية

إنّ الشعيّات والفطريات والزراقم والطحالب تفرز مواد كالجيوسمين،2، ميثيل ايزو بورنيول (Geosmine,2, methyl isoborneol) وغيرها من المواد الكيميائيّة التي تؤثر على طعم مياه الشرب حتى ولو كانت موجودة بكميات ضئيلة جدا (بضعة نانوغرامات في اللتر الواحد من مياه الشرب).

الملحق رقم (2)

(إعلامي)

جدول الملوثات الكيميائية التي تؤثر على قبولية مياه الشرب

المادة الكيميائية	الحد الأقصى المسموح به
Chlorophenols: 2-chlorophenol 2,4-dichlorophenol 2,4,6-trichlorophenol	<0.1 µg/l(taste)----<10 µg/l(odour) <0.3 µg/l(taste)----<40 µg/l(odour) <2 µg/l (taste)----<300 µg/l(odour)
Ethylbenzene	72-200 µg/l threshold for taste
Hydrogen sulphide	0.05-0.1mg/l threshold of taste and odour
Monochlorobenzene	10---20 µg/l threshold for taste and odour 40---120 µg/l threshold for odour
Sulfates as sodium	250 mg/l threshold of taste
Toluene	40---120 µg/l threshold of taste 24-170 µg/l threshold of odour
Trichlorobenzenes: 1,2,3-trichlorobenzene 1,2,4-trichlorobenzene 1,3,5-trichlorobenzene	10 µg/l(threshold of taste) 5---30 µg/l(taste),30 µg/l(taste and odour) 50 µg/l (taste)
Dichlorobenzene: 1,2-dichlorobenzene 1,4-dichlorobenzene	2-10 µg/l(odour), 1 µg/l(taste) 0.3-30 µg/l (odour), 0.6 µg/l (taste)
Xylenes	300 µg/l (taste), 20-1800 µg/l (odour)
Zinc (Zn)	4 mg/l threshold of taste
Styrene	4 – 2600 µg/l
Anionic detergents as MBAs	0.2 mg/l

الملحق رقم (3)

(إعلامي)

الإختبارات الجرثومية التي يتمّ إجراؤها عند الضرورة

الخصائص	الحد الأقصى المسموح به
السالمونيلا Salmonella	Absence in 1-5 l
البكتيريا اللاهوائية المختزلة للكبريتيت Sulfite reducing anaerobes	< 1 CFU in 50 ml

المُلحق رقم (4)

(إعلامي)

قائمة بالفيروسات والأوالي التي تنتقل بواسطة مياه الشرب

List of Viruses قائمة الفيروسات

Adenoviruses

Astroviruses

Enteroviruses

Hepatitis A virus

Hepatitis E virus

Noroviruses

Rotaviruses

Sapoviruses

List of Protozoa قائمة الأوالي

Acanthamoeba spp.

Cryptosporidium hominis/ parvum

Cyclospora cayetanensis

Entamoeba histolytica

Giardia intestinalis

Naegleria fowleri

الملحق رقم (5)

(إعلامي)

النويدات المشعّة الفرديّة

Individual Radionuclides

المستويات الموصى بها للنويدات المشعّة الشائعة[أ] الطبيعية والاصطناعية لعامة الناس

الفئة	النويدة المشعّة	معامل الجرعة (Sv/Bq)	المستوى الموصى به[ب] (Bq/l)
نظير مشعّ يتشكّل طبيعيًّا ويبدأ سلسلة انحلال اليورانيوم[ج]	Uranium-238	4.5 × 10−8	10
نظائر مشعّة تتشكّل طبيعيًّا وتنتمي إلى سلاسل انحلال اليورانيوم	Uranium-234	4.9 × 10−8	1
	Thorium-230	2.1 × 10−7	1
	Radium-226	2.8 × 10−7	1
	Lead-210	6.9 × 10−7	0.1
	Polonium-210	1.2 × 10−6	0.1
نظير مشعّ يتشكّل طبيعيًّا ويبدأ سلسلة انحلال الثوريوم	Thorium-232	2.3 × 10−7	1
نظائر مشعّة تتشكّل طبيعيًّا وتنتمي إلى سلاسل انحلال الثوريوم	Radium-228	6.9 × 10−7	0.1
	Thorium-228	7.2 × 10−8	1
نويدات مشعّة اصطناعيّة يمكن إطلاقها في البيئة كجزء من منتجات الانشطار المتوفّرة في انبعاثات المفاعلات النوويّة أو تجارب الأسلحة النوويّة	Caesium-134 [د]	1.9 × 10−8	10
	Caesium-137 [د]	1.3 × 10−8	10
	Strontium-90 [د]	2.8 × 10−8	10
نويدة اصطناعية يمكن إطلاقها في البيئة كمنتج انشطار (أنظر أعلاه). ويمكن استخدامها أيضًا في إجراءات الطب النووي وبذلك يمكن إطلاقها في أجسام مائية من خلال مخلفات مياه الصرف الصحّي.	Iodine-131 [د]، [ه]	2.2 × 10−8	10

نظير مشع للهدروجين المنتج اصطناعيًا كمنتج انشطار من مفاعلات الطاقة النووية وتجارب الأسلحة النووية. ويمكن أن يتواجد طبيعيًّا في البيئة بكمّية ضئيلة جدًّا. تواجده في مصدر مياه يفيد عن تلوّث صناعيّ محتمل.	Tritium [ه]	1.8×10^{-11}	10 000
نظير مشعّ يتكوّن طبيعيًّا ومتوزّع بشكلٍ واسع في الطبيعة ومتوفّر في المركّبات العضويّة وفي جسم الإنسان	Carbon-14	5.8×10^{-10}	100
نظير اصطناعي يتشكّل في المفاعلات النوويّة ويتوفّر أيضًا بكمّيات قليلة للغاية في خامات اليورانيوم الطبيعيّة	Plutonium-239 [د]	2.5×10^{-7}	1
منتج ثانوي لنظير اصطناعي يتشكّل في المفاعلات النوويّة	Americium-241 [ه]	2.0×10^{-7}	1

أ- هذه القائمة ليست شاملة، ويجب التحقيق في نويدات مشعّة أخرى في بعض الظروف.

ب- يتمّ تدوير المستويات الموصى بها إلى الرقم الكامل الأقرب.

ج- تتوفّر مستويات موصى بها منفصلة لنظائر اليورانيوم المشعّة المفردة من حيث نشاطها الإشعاعي (أي ما يعبّر عنه ببيكريل/لتر). إنّ القيمة الإسترشادية المؤقتة للمتحوى الإجمالي لليورانيوم في مياه شرب هي 30 ميكروغرام/لتر بحسب سميّتها الكيميائية التي تعتبر راجحة مقارنة بسميّتها الاشعاعية.

د- إنّ هذه النويدات المشعّة قد تتواجد في مياه الشرب في حالات عاديّة أو قد تتواجد بجرعات شحيحة جدًّا بحيث لا يكون لها أيّ تأثير على الصحّة العامّة. لذلك فهي تعتبر ذات أولويّة منخفضة للتحقيق في حال تخطّت المستويات الموصى بها.

ه- على الرغم من أنّه لن يتمّ كشف اليود والترتيوم بواسطة قياسات النشاطات الإجمالية القياسية وبالرغم من عدم ضرورة التحاليل الروتينية لهذه النويدات المشعة، إلا أنّه وفي حال وجود ما يشير إلى إمكانيّة توفّر هاتين المادتين، يجب استخدام تقنيات قياس وأخذ عيّنات خاصّة بالنويدات المشعّة، ولهذا السبب تمّت إضافتهما إلى هذا الجدول.

الملحق رقم (6)

(إعلامي)

قائمة بأحماض الخل

List of Haloacetic Acids

الحد الأقصى المسموح به	أحماض الخل
	Methyl chloroacetate
	Methyl dichloroacetate
	Methyl trichloroacetate
	Methyl bromoacetate
	Methyl bromochloroacetate
	Methyl dibromoacetate
	2,4-Dichloroanisole
	2,4,6-Trichloroanisole
	Chloroacetic acid
0 mg/l	Dichloroacetic acid
0.3 mg/l	Trichloroacetic acid
	Bromoacetic acid
	Bromochloroacetic acid
	Dibromoacetic acid
	2,4-dichlorophenol
	2,4,6-Trichlorophenol

الملحق رقم (7)

(إعلامي)

قائمة الفتالات

List of Phthalates

الفتالات	الحد الأقصى المسموح به	التركيبة الجزيئية
Bis (2-n-butoxyethyl) phthalate BBEP	0.006 mg/L	C20H30O6
Bis (2-ethoxyethyl) phthalate BEEP	0.006 mg/L	C16H22O6
Bis (2-ethylexyl) phthalate DEHP	0.006 mg/L	C24H38O4
Bis (2-methoxyethyl) phthalate BMEP	0.006 mg/L	C14H18O6
Bis (4-methyl-2-pentyl) phthalate BMPP	0.006 mg/L	C20H30O4
Butyl Benzyl phthalate BBP	0.006 mg/L	C19H20O4
Diamyl phthalate DAP	0.006 mg/L	C18H26O4
Di-n-butyl phthalate DBP	0.006 mg/L	C16 H22 O4
Dicyclohexyl phthalate DCP	0.006 mg/L	C20H26O4
Diehtyl phthalate DEP	0.006 mg/L	C12H14O4
Dihexyl phthalate DHP	0.006 mg/L	C20H30O4
Diisobutyl phthalate DIBP	0.006 mg/L	C16H22O4
Dimethyl phthalate DMP	0.006 mg/L	C10H10O4
Dinonyl phthalate DNP	0.006 mg/L	C26H42O4
Di-n-octyl phthalate DOP	0.006 mg/L	C24H38O4

الملحق رقم (8)

(إعلامي)

قائمة الأمينات النتروزوية

List of Nitrosamines

التركيبة الجزيئية	الحد الأقصى المسموح به	العطريات النتروزية والنتراميناات
(C2H5)2NNO	10 ng/L	N-Nitrosodiethylamine (NDEA)[3,4]
C2H6N2O	10 ng/L	N-Nitrosodimethylamine (NDMA)[3,5]
C6H14N2O	10 ng/L	N-Nitrosodi-n-propylamine (NDPA)[3,4]
C8H18N2O	10 ng/L	N-Nitrosodi-n-butylamine (NDBA)[3,4]
C3H8N2O	10 ng/L	N-Nitrosomethylethylamine (NMEA)[3,4]
C4H8N2O2	10 ng/L	N-Nitrosomorpholine[4]
C5H10N2O	10 ng/L	N-Nitrosopiperidine (NPIP)[4]
C4H8N2O	10 ng/L	N-Nitrosopyrrolidine (NYPR)[3,4]

الملحق رقم (9)

(إعلامي)

قائمة المستحضرات الدوائية

List of Pharmaceuticals

أسماء وفئات المستحضرات الدوائية ومنتجات الرعاية الشخصيّة :

المركّب	الفئة
Acetaminophen	Analgesic
Albuterol	Steroid
Ampicillin	Antibiotic
anhyrochlortetracyline (ACTC)	Antibiotic
anyhydrotetracyline (ATC)	Antibiotic
Azithromycin	Antibiotic
Caffeine	CNS stimulant
Carbadox	Antibiotic
Carbamazepine	analghesic/anticonvulsant
cefotaxime	Antibiotic
chlortetracycline	Antibiotic
cimetidine	Antihistamine
ciprofloxacin	Antibiotic
clarithromycin	Antibiotic
clinathromycin	Antibiotic
cloxacillin	Antibiotic
codein	sleep-inducing-analgesic
cotinine	Alkaloid
dehydronifedipine	hypertension drug
demeclocycline	Antibiotic
digoxigenin	Steroid
digoxin	steroid glycoside
diltiazem	calcium channel blocker
1,7-dimethylxanthine	CNS stimulant
diphenhydramine	Antihistamine

Antibiotic	doxycycline
Antibiotic	enrofloxacin
Antibiotic	4-epinhydrochlortetracycline
Antibiotic	4-Epinhydrotetracycline (EATC)
Antibiotic	4-Epichlortetracyclin
Antibiotic	4-Epioxytetracycline (EOTC)
Antibiotic	erthromycin
Antibiotic	erythromycin anhydrate
Antibiotic	flumequine
Antidepressant	fluxoetine
Hypolipidemic	gemfibrozil
NSAID	Ibuprofen
Antibiotic	izochlortetracycline
Antibiotic	lincomycin
Antibiotic	lomefloxacin
diabetes drug	metformin
Antifungal	miconazole
Antibiotic	minocycline
Antinflammatory	naproxen
Antibacterial	norfloxacin
acytelated progestin	norgestimate
Antibiotic	ofloxacin
Antibiotic	ormetoprim
Antibiotic	oxacillin
Antibiotic	oxalinic acid
Antibiotic	oxytetracycline
Antibiotic	penicillin V
Antibiotic	penicillin G
Antihistamine	ranitidine
Antibiotic	roxithromycin
Antibiotic	sarafloxacin
Antibacterial	sulfachloropyridazine

Antibacterial	sulfadiazine
Antibiotic	sulfadimethoxine
Antibacterial	sulfamerazine
Antibacterial	sulfamethazine
Antibacterial	sulfamethiazole
Antibiotic	sulfamethaoxale
Antibacterial	sulfanilamide
Antimicrobial	sulfathiazole
Antibiotic	tetracyclin
Antifungal	thiabendazole
Antibacterial	triclocarban
Antibacterial	triclosan
Antibacterial	trimethoprim
Antibiotic	tylosin
Antibiotic	virginiamycin
Anticoagulant	warfarin
Antibiotic	meclocycline
Antibiotic	4-epitetracyclinre

الملحق رقم (10)

(إعلامي)

ملوثات سلفونات البيرفلوروكتاني

Perfluorooctane sulfonate PFOS

المادة الكيميائية	الحد الأقصى المسموح به
Perfluorooctanesulfonic acid	200 ng/l

الملحق رقم (11)

(إعلامي)

المصطلحات التقنية

إنكليزي	عربي
Conductivity	الموصلية
PH value	تركيز شوادر الهدروجين
Organoleptic parameters	خصائص حسية
Turbidity	عكارة
Total dissolved solids	المواد الصلبة الحلولة
Total hardness	قساوة إجمالية
Pesticides	مبيدات
Treatment	معالجة
Disinfectants	المواد المطهرة
Disinfection by – products	منتجات التطهير الثانوية
Halogenated acetonitriles	الأسيتونتريلات المهلجنة
Contaminants	ملوثات
Pipes and fittings	الأنابيب والتوصيلات
Pesticide residues	بقايا المبيدات
Gross alpha activity	النشاط الإشعاعي ألفا الإجمالي
Gross beta activity	النشاط الإشعاعي بيتا الإجمالي
Becquerel	بيكريل
Disintegration	إنحلال
Protozoa	حيوانات أولية - الأوالي
Vesicles	حويصلات
Larvae	يرقات
Amaeba	الأميبا
Algae	طحالب
Fungi	فطريات
Total coliforms	قولونيات إجمالية

Thermotolerant coliforms	قولونيات متحملة للحرارة
E. coli	إشريشيا كولاي
Intestinal enterococci	مكورات معوية
Pseudomonas aeruginosa	بسودوموناس أيروجينوزا
Salmonella	سالمونيلا
Sulfate reducing anaerobes	أحياء لاهوائية مختزلة للكبريت
Biologically derived contaminants	ملوثات ناتجة عن عوامل حيوية
Actinomycetes	الشعيات
Cyanobacteria	الزراقم
Geosmine,2,methyl isoborneol	الجيوسمين،2، ايزو بورنيول
Acceptability	قبولية
Individual Radionuclides	النويدات المشعة الفردية
Radionuclide	النويدة المشعة
Dose coefficient	معامل الجرعة
Guidance level	المستوى الموصى به
Radioactive isotope	نظير مشع
Decay series	سلاسل إنحلال
Fission	الإنشطار
Haloacetic Acids	أحماض الخل
Phthalates	الفتالات
Nitrosamines	الأمينات النتروزوية
Nitroaromatics and Nitramines	العطريات النتروزية والنترامينات
Molecular formula	التركيبة الجزيئية
Pharmaceuticals	المستحضرات الدوائية
Personal-care products	منتجات الرعاية الشخصية
Perfluorooctane sulfonate	سلفونات البيرفلوروكتاني
Informative	إعلامي

PART 2

MECANICAL SPECIFICATION

VOLUME 2
SPECIFICATIONS

PART 2
MECHANICAL ENGINEERING SERVICES

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CHAPTER ONE

GENERAL TECHNICAL REQUIREMENTS

1.0 GENERAL TECHNICAL REQUIREMENTS

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CHAPTER ONE
GENERAL TECHNICAL REQUIREMENTS

1. SCOPE, REGULATIONS AND STANDARDS

Specification Scope

This Specification covers the supply, installation and testing of all necessary equipment required for the complete Mechanical and Ventilation Services as described in the attached Contract Documents and incorporates standard descriptions for equipment and the installation to be provided under this Contract. The clauses shall be read in conjunction with the accompanying General Conditions of Contract, Scope of Works document, Schedules and Drawings.

The words 'as indicated', 'where indicated', 'unless otherwise indicated', refer to requirements identified elsewhere in the documents issued in connection with the Contract, e.g., on a drawing, in the specification or in a schedule.

The extent of the work shall comprise the system engineering, the whole labor and materials required to form a complete installation, together with such tests, adjustments and commissioning as prescribed in subsequent clauses and otherwise as may be required in order to provide an effective working installation to the satisfaction of the Engineer.

The words 'complete installation' in the foregoing clause shall mean not only the major items of plant and equipment covered by this Specification, but all the incidental sundry components that are required for the complete execution of the works; also, for the proper operation of the installation, together with associated labor charges, whether or not these sundry components are mentioned in detail in the tender documents issued in connection with the Contract.

The Contractor shall comply with the latest applicable Standards of the followings:
1) ASME, American Society of Mechanical Engineers.
2) ASHRAE, American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.
3) ANSI, American National Standards Institute.
4) CIBSE, Chartered Institute of Building Services Engineers.
5) ASTM, American Society of Testing Materials.
6) NEMA, National Electrical Manufacturers Association.
7) BS, British Standards.
8) ASPE, American Society of Plumbing Engineers.
9) DIN Deutschers Institute Für Norming.
10) FM, Factory Mutual.
11) IBR, Institute of Boiler and Radiator Manufacturers.
12) ISO, International Standardization Organization.
13) IPC, International Plumbing Code.

Compliance with Regulations

The work shall comply with all relevant stringent statutory instruments and regulations, applicable to local codes and regulations, at the date of construction and in particular with the following:

The requirements of the Local Authority Planning Department, District Surveyor or equivalent.

The requirements of the Local Fire Officer.

The Local Water Authority Regulations.

All installations and materials used for the works shall be carried out and provided in full compliance with the appropriate Specifications or Codes of Practice issued by the above-mentioned institutions.

Alternatively, the installations and materials may be carried out and provided to other equivalent internationally recognized standards provided the standards are acceptable to the Engineer and the relevant local Authorities.

2. INSTALLATION GENERAL

General

The Contractor shall allow in his Tender for all labor, materials, tools, plant and equipment required to supply, deliver and erect all equipment, pipework, fittings, etc., described in this Specification and indicated on the drawings to form a complete working facility including tests and commissioning. This shall mean not only the main items of plant and equipment but also all incidental sundry components with their labor charges necessary for the complete execution of the works.

The Contractor shall ensure that his work is installed in the correct sequence.

The Contractor shall be responsible for ensuring that all sections of the work and all materials are compatible with one another. The Contractor shall check and ensure that all of the equipment and works offered by him will fit into the space provided in the garden.

Operating Conditions

All equipment will be required to operate successfully in the climatic conditions prevailing in the locality and have a working life comparable with that expected from top quality equipment operating in more temperate conditions.

Workmanship and Materials

Materials and workmanship generally shall be of the highest standard and the Specification shall be closely adhered to. Materials shall be brand new bearing stamped ratings as required.

Where materials or equipment are not described in detail, they shall be of the best quality available and shall comply with the appropriate Standards. The Contractor shall, if required, submit drawings or samples of such materials or equipment to the Engineer for his approval before use on the Contract works.

Samples of Workmanship

The Contractor shall provide the following samples of workmanship for the approval of the Engineer:

Samples of pipework.

The samples shall be submitted to the Engineer as soon as possible after the order for the work has been placed so that the subsequent delivery of the associated equipment will not be delayed. No orders shall be placed until the Engineer has approved the samples.

All samples shall be correctly labelled and forwarded to the Engineer's office or to the site as directed by the Engineer. At least 14 days shall be allowed for approval of samples by the Engineer.

Unless otherwise stated, approved samples shall be retained on site by the Engineer, who will reject all such materials, which do not correspond with the approved samples. Rejected materials shall be removed from the site immediately.

Where the Engineer carries out an inspection of materials before they leave the manufacturer's premises prior to being delivered to the site, the Engineer shall be at liberty to reject any such materials after delivery should he consider them to be in any way unsatisfactory notwithstanding the preliminary inspection and tests at the manufacturer's premises.

The Contract shall include for the cost of remedial work or tests and inspections necessary due to unsatisfactory material and/or equipment.

3. NOISE AND VIBRATION CONTROL

Anti-Vibration Mountings

All equipment containing moving parts generating noise and vibration shall be mounted upon specially designed vibration isolators. All service connections to such equipment shall include customized flexible connectors and shall be installed in such a way as to prevent transmission of noise and vibration to the structure, other areas of the building or to other items of equipment.

Where required, mountings shall be provided with a positioning or restraining device, which will prevent the equipment position changing if its load changes, for example, during draining down of the equipment, or other maintenance.

Mounting selection should allow for any eccentric load distribution or torque reaction, so that the design deflection is achieved on all mountings under operating conditions.

4. INSPECTION, TESTING AND COMMISSIONING

General

All the works provided as part of this contract shall be inspected, tested, regulated and commissioned in accordance with all relevant Standards, Specifications and Codes of Practice and the details given in the specification and/or as indicated on the drawings, to the entire satisfaction of the Engineer.

All installations shall be inspected and tested in sections as the work proceeds and on completion

as composite systems and it shall be noted that the Engineer may require to inspect or test any equipment during manufacture at the manufacturers works. All necessary arrangements shall be made as part of this contract.

All tests shall be arranged in co-operation with the Engineer and other interested parties shall be given seven (7) days notice in writing of the time, location and nature of the test to be performed. No test shall be considered valid unless the Engineer is present.

All necessary skilled and unskilled labor shall be provided for attendance duties during the test (including pre and post test activities) and the test medium shall be provided and subsequently disposed of except where specifically stated otherwise.

Any defects occurring at any time during the test duration shall be made good and a complete re-test shall be carried out, all at no cost to the contract.

Where failure during a test, inspection or commissioning process results in damage to the building fabric and/or any services or requires subsequent builders work in connection to be carried out, then the remedial work shall be carried out at no cost to the contract.

Where valve and flange boxes and access covers and de-mountable ceilings need to be removed and replaced during the commissioning of the works, these shall be removed, protected from damage and replaced in good order by the Contractor.

The Contractor shall arrange a progressive regulation testing and balancing program to achieve the Date of Completion of the Contract Works.

During the Commissioning Period, the Contractor will hold commissioning meetings, which will be attended by the Engineer. The Senior representative of the Contractor's site and Management staff shall attend the meetings which will be held at fortnightly intervals.

The meetings may continue after issue of the 'Taking Over Certificate' for as long as necessary to deal properly with any outstanding works and defects in the Contract Works.

All representatives present during inspection, testing and commissioning shall be fully conversant with the system concerned and the method of system and instrument operation. Manufacturers or specialist contractors representatives shall attend where specifically indicated elsewhere in the Specification or where necessary to ensure full service and co-operation is available to the Engineer to enable the works to be tested and commissioned in accordance with the requirements of the Specification.

All necessary precautions shall be taken to safeguard against frost damage during inspection, testing or commissioning. Any damage so caused shall be made good at no cost to the contract.

All tests shall last for the minimum time period stated or for a longer period if necessary to ensure all sections have been fully examined as required by the test.

All performance tests shall be carried out initially prior to the Engineer being requested to witness the tests and thereby avoid unnecessary re-tests being required.

Provision of Test Points:

The Bills of Quantities do not separately enumerate test point in pipework and ductwork installations. These are deemed to be included in the pipework or ductwork installation. The

Contractor shall allow sufficient points for the correct and complete regulation, testing, and commissioning of the installations. All test points shall be indicated on the Working and Record Drawings.

All test points shall be provided which are necessary to carry out the specified tests and commissioning requirements including facilities for temperature, pressure, pressure drop, volume flow, and other relevant conditions to be measured. Such points shall be fitted with removable plugs, flanges or other approved devices appropriate to the service concerned. Permanent test or reading points shall be provided only where specified elsewhere.

Testing of Soil, Waste, Vent and Rainwater Pipework

All works which are to be concealed shall be tested before being finally enclosed, a final test shall be made upon completion for soundness and performance strictly in accordance with the British Standard 5572 for Sanitary Pipework, or equivalent and shall be to the entire satisfaction of the Engineer.

Cleaning and Flushing Out of System

Prior to setting systems to work all systems shall be thoroughly cleaned and pipework systems shall be flushed out.

Water installations shall be flushed out using cold water at maximum mains pressure.

During the cleaning process the flow shall be interrupted occasionally to dislodge debris.

Tanks and vessels shall be similarly cleaned.

Water services for domestic use shall then be chemically cleaned by Chlorine treatment as described elsewhere, tested and set to work to comply fully with the UK Department of Health Code of Practice on the Control of Legionellae, and any other recognized recommendations to prevent the development of legionellae bacteria.

All cleaning and flushing out operations shall be conducted in the presence of the Engineer.

Following the cleaning and flushing out operations a signed certificate shall be provided confirming that the systems have been adequately and satisfactorily flushed through and cleaned. This certificate shall be countersigned by the Engineer and forwarded to the Engineer. No commissioning whatsoever shall take place until the Contractor has received written acknowledgement of receipt of this certificate from the Engineer.

Commissioning of Services

All systems shall be filled with the working fluid, vented as necessary, and brought to operating conditions and the flows then regulated to the design values.

The balancing and testing of systems to verify performance of the engineering systems shall be carried out by a team of experienced specialist Balancing and Testing Engineers who shall be responsible to the Contractor for the complete balancing and testing of all systems and the production of a complete log of all tests including any comments they may wish to make for

improving the performance of the installations.

Following regulation and balancing procedures all plant systems shall be put into operation and examined to ensure that the installations are operating correctly.

5. HANDOVER PROCEDURES AND DOCUMENTATION

Operation and Maintenance Instruction Manuals

Three copies of a manual, (or series of manuals if required by the extent of the installations) shall be provided 1 month prior to the anticipated completion date of the contract and shall contain complete operational and maintenance instructions for the various installations.
The purpose of the manuals is to:

(a) Familiarize maintenance staff with the overall philosophy of the project.

(b) Describe the Mechanical and Public Health Services systems and their inter-relation with other systems.

(c) Act as central point of reference and as such, to contain specific references to Record Drawings and Vendors/ Manufacturers literature to enable the reader to easily locate further information.

(d) Give all the specific information and instructions including safety information, to enable an operator, of technician level, to manually start and run each system at Local Control Station and from any Central Monitoring Control Station included in the Contract. This shall also include procedures for start-up of systems after an emergency shutdown.

(e) To give details of action to be taken by operators in event of fire, plant malfunction or alarm condition occurring.

(f) Provide information and warnings necessary to ensure the health and safety of the general public together with operating and maintenance staff.

The manual(s) shall be agreed in draft form with the Engineer and shall be primarily sub-divided into (a) instructions relevant to items of plant or equipment and (b) instructions relevant to complete systems.

The plant and equipment section shall contain the manufacturers printed maintenance and operator's instructions relevant only to the particular item of equipment concerned. General catalogues will not be acceptable.

The section dealing with complete systems shall be sub-divided into each service with a ready means of reference and detailed index. The function and manner of operation of each system shall be clearly described together with illustration and line diagrams in schematic form showing the location and function of control valves, items of equipment and which spaces or areas are served by these items. The color coding and identification systems employed shall be explained, and a full lubrication schedule for all lubricated items of plant and equipment shall be included.

Operation and Maintenance charts shall be included for each plantroom area and shall provide essential information and reference data for daily running checks together with weekly, monthly and annual maintenance procedures.

Where more than one system can be shown on a single chart without loss of clarity this will be acceptable. Complex systems must be shown on individual charts.

A special section shall be included in the manual for dealing with fault finding routines and emergency procedures in case of plant or system malfunction.

All equipment shall be scheduled in the document including a complete valve schedule with all items identified in accordance with the plant reference provided on the item of plant or equipment and the as-installed drawings.

A complete itemized list of essential and secondary spares together with the manufacturers ordering reference numbers shall be provided. A list of plant manufacturers names, addresses and telephone numbers shall also be included.

The Operation and Maintenance manual(s) shall include copies of all manufacturers works test certificates for plant items such as heat generating plant, heat exchangers, calorifiers, refrigeration machines, tanks, vessels, motors, fans, pumps, controls, electrical and other like equipment. In the case of fans and pumps copies of the manufacturer's characteristic curves for the actual unit fitted shall be supplied.

Labels and Identification

Items of plant such as fans, pumps, calorifiers, etc. shall bear a metal label fixed by the manufacturer giving the makers name, date of manufacture and manufacturer's serial number, test and working pressures, duty, kW, phasing, hertz, speeds, BS number, etc. as appropriate to the item of plant such that its origins and details may be easily traced at a later date.

Schedule of Outstanding Items and Defects

Until the installation is finally taken over as complete, the Contractor shall be responsible for any necessary protection of the installation and electrical safety requirements.

On the completion of the Contract an inspection of the installation will be made by the Engineer. During the inspection a schedule of outstanding items or defects will be provided by the Engineer.

All items included in this Schedule shall be attended to within fourteen days of the date of the inspection.

Certificate of Practical Completion

When the Contractor has demonstrated to the Engineer and to the Engineer's complete satisfaction that the works are operating as intended within the design limits and tolerances of the manufactured items, then the Engineer will issue a Certificate of Practical Completion subject to the clearance of any outstanding items or defects within 14 days of the date of the Certificate and the responsibility for the operation of the plant will pass from the Contractor to the Employer or as otherwise agreed with the Engineer.
This Certificate will not be authorized until all items in this clause have been cleared to the Engineer's satisfaction.

Responsibility During Period of Maintenance

The Contractor shall include for making checks of the Thermal Environment in the building when

occupied and in use by the Client and for making normal adjustments to the commissioning and testing settings to tune the installations to the actual building usage.

The Contractor shall include for making checks of the water flow capacities on domestic water services in buildings when occupied and used by the Client and for making normal adjustments to the commissioning settings to tune the installation to the actual building usage.

Testing of Plant Capacity and Efficiency

A heating test shall be carried out under maximum load and design conditions to check the actual plant capacity as supplied and installed. Where possible, thermal efficiency checks shall be made. These tests shall be carried out during the year following practical completion.

Adjustments During Course of Period of Maintenance

The Contractor shall include for making a further visit to the site before the end of the Period of Maintenance to check over and, if necessary, re-adjust the system.

Certificate of Making Good Defects

The Contractor shall carry out a thorough detailed examination of the installations between the eleventh and twelfth month of the defects liability period and shall put right any outstanding works or defects that might have occurred under the Defects Liability Period in the Conditions of Contract.

On completion of such works, and agreement that the requirements of the Conditions of Contract and Specification have been met, the Engineer will recommend to the Architect that a Certificate of Making Good Defects can be issued.

6. RE-MODELLING

Contractor, at Contractor's expense, will be responsible for any items not included in bid, but are shown on plans or specified in the General Specifications or required by local codes and ordinances.

In order to do so the contractor shall inspect all the existing mechanical prior to pricing. All work to conform to all applicable codes. Contractor shall provide all necessary Mechanical works, maintenance, cleaning, relocation or removing, testing & commissioning for the existing Mechanical system to ensure properly working system. Work performed under this section shall result in complete and updated plumbing systems. All material, labor, equipment, and other items to complete the plumbing system as outlined in Bid Document shall be furnished.

All plumbing work, whether existing and to be kept, or new installation performed under this contract SHALL BE INSPECTED, tested, and approved by the Consultant.

Cutting, patching, and cleaning shall be done as necessary by the contractor performing the work; however, special permission shall be obtained from the Consultant before cutting structural members of finished construction.

The plumbing contractor shall clean away all debris caused by his work at the close of each work day, and upon completion of the job.

A salvaged plumbing fixture and upon approval by the Engineer, shall be handed to the Owner representative.

Upon removal of old fixtures, contractor shall inspect all cleats, supports, and floor joists to assure a solid and secure installation. If unforeseen repair or replacement is needed, contractor shall notify the Engineer.

The contractor shall further determine if a change in the location of any plumbing fixture and/or pipes is necessary for proper functional replacement of the unit, and to meet codes.

Repair All Existing Supply Connections.

Furnish and install all labor and materials necessary to repair all existing supply connections in and under structure. All work to conform to local plumbing code.

CHAPTER TWO

SANITARY AND WASTE PIPEWORK INSTALLATION

2.0 SANITARY AND WASTE PIPEWORK INSTALLATION

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1. General Preamble

2. Materials

3. Pipe work Materials

4. Pipe work Installation

5. Waste Installation

1. GENERAL PREAMBLE

Scope of Work

Soil, Waste, Vent and Rainwater Installations.

Waste Installations.

All Overflows Pipes.

Sanitary Fittings

Shall include the following:

Order, take delivery, store, and protect during the course of the contract all sanitary ware including fixtures and fittings all in accordance with the sanitary fitting specification and standard.

Allow for fixing and protecting all sanitary ware, fixtures and fittings as indicated, all strictly in accordance with the manufacturers' recommendations.

All pipework and fittings used in the hot and cold-water service installations shall be as specified herein.

Allow for all overflows and warning pipes where indicated on the drawings using pipework and fittings specified herein.

2. MATERIALS

General

All pipework, fixtures and fittings shall comply strictly in accordance with the relevant International Standard Specification.

Standards

Where a British Standard and/or Code of Practice is quoted in this Specification, refer to the latest published standard and any subsequent amendments.

British Standard Institution documents referred to in this Specification are:

BS.4514 Unplasticized PVC soil and ventilating pipe, fittings and accessories or approved equal EN.

BS.5254 Polypropylene waste pipes and fittings (external diameter 34.6 mm, 41.0 mm and 54.1 mm) or approved equal EN.

BS.5255 Plastics waste pipe and fittings or approved equal EN.

BS.3943 Plastics waste traps or approved equal EN.

BS.2494 Materials for elastomeric joint rings for pipework and pipelines or approved equal EN.

British Standard Code of Practice referred to in this Specification are:-

BS.CP.5572 Sanitary Pipework or approved equal EN.

BS.6367 Drainage of Roofs and Paved Areas or approved equal EN.

Building Standards and Regulations

All pipework and fittings shall be installed strictly in accordance with Local Authority Regulations or equivalent.

Termination

The installation shall be deemed to terminate at the buried drain connections.

3. PIPEWORK MATERIALS

Main Soil Waste and Rain Water

Pipe Size	Material
110mm, 160mm 200mm 300mm	- UPVC (EN – 1401)

Main Soil, Waste Rain Water and Vent Pipework shall be deemed to include horizontal pipework underground drainage.

Branch Soil, Waste and Vent Pipes

Pipe Size	Material
- 50mm	- UPVC (DIN. 19531)
- 82mm 110mm 160mm 200mm	- UPVC(BS.4514)+(EN.1329)

Branch Soil, Waste and Vent Pipework shall be deemed to include for all vertical and/or horizontal pipework between the connection to drain or main soil, waste and vent stack, and the terminal connections to the Sanitary appliance or fitting.

All soil and waste pipe work discharging from sump pits shall be cast iron.

Rainwater Pipes

Material	Pipe Size
UPVC (BS.4514) + (EN.1329)	φ 110 - φ 200

General Requirement

There shall be no deviation from the details indicated on the drawings, any alterations to the design intent without prior approval shall be restored to the original design at no extra cost to the contract unless it is proven that the original design cannot be accommodated.

The entire installation shall be carried out to the satisfaction of the Architect/Engineer or his appointed representative.

4. PIPEWORK INSTALLATION

General

All pipework shall be installed truly vertical or if horizontal to the gradient dictated by the design.

All bends and offsets shall be kept to the minimum number and if required be of a wide sweep pattern.

All pipework shall be cut clean and square with the axis of the pipe with all sharp edges and/or burrs removed before installation.

Should any blockage occur within the system caused by general negligence or abuse pipework shall be removed and the system thoroughly cleaned out at no extra cost to the contract.

Pipework Fixtures and Fittings

All pipework fixtures and fittings shall be installed using the correct fixtures and fixing procedures including support brackets to suit the specified materials, and hold pipework secure.

All bracket and support fixings shall be in accordance with the details shown on the coded detail drawings.

UPVC Pipework and Fittings

Shall comply to British Standard 4514 bear the British Standard Kite Mark, or equivalent and shall be installed strictly in accordance with manufacturers recommendations.

All pipework shall be supplied in plain ended lengths.

The pipe and fittings shall be to color grey, British Standard 5252 with the exception of water closet connections which shall be colored white where exposed to view.

Method of jointing shall be a combination of solvent welding using the manufacturer's approved solvent cement, with seal ring fittings used where necessary to accommodate thermal movement. The sockets of standard fittings shall be converted to incorporate a rubber seal ring where required.

UPVC Pipework Installation

All pipework shall be installed to accommodate thermal movement, flexible joints shall be incorporated at all fixed points and changes of direction with a secure fixing bracket located in the retention groove moulded on the socket of the fitting.

Waste boss connections when fitted to the pipes shall consist of two parts with inner and outer flanges, solvent welded as a complete unit with inbuilt gradients of 1 1/4o. Where it is not possible to gain access to the bore of the soil pipe self-locking bosses with integral clamping devices shall be used providing the mating surfaces are suitable for and used with solvent weld cement.

Access shall be provided to gain entry into all pipework either by means of an integrally moulded door in an access fitting with external fitted rubber seal and secured with two galvanized bolts and nuts, or alternatively a two piece clamp type door fitted into the pipe run.

Where WC connections are to be fixed in a range a single manifold branch shall be used comprising a single branch with a standard WC connector welded together, up to six WCs may be connected on either side of the soil stack using the available left or right hand fittings as required.

The correct angle and type of fitting to suit the application shall be as described in the manufacturers Product Handbook.

The system shall be installed strictly in accordance with the Product Handbook complying with the recommendations of BS.4940.

5. WASTE INSTALLATION

Access Fittings

All fittings shall give full width access into the bore of the pipe and located as indicated on the drawings.

Access Location (General)

Access points shall be provided to give full access to all sections of installation at the locations indicated on the drawings, to enable section testing and efficient maintenance operations to be carried out and to enable every section of Soil, Waste or Rainwater Pipework to be rodded, tested, inspected and to enable the easily removable of objects or debris from the system.

Roof Vent Fittings

All vent pipes passing through the roof shall be fitted with a connector suitable for a weatherproof seal and to ensure a completely watertight arrangement.

The pipe shall terminate 450mm above finished roof level with a section of spigot end and vent cage, complete with a weathering shroud to enclose the waterproof finish.

WC's Connectors

Pipework connections to WC's shall be flexible self-sealing connectors incorporating multiple plastic and rubber seal gaskets. The connector shall incorporate outward facing rubber seals and plastic fins for insertion into the pipe, and an internal rubber seal with plastic shroud for connection to the WC pan.

The Connectors shall suit the specified pipe materials.

Storage of Pipework and Fixtures and Fittings

All pipework fixtures and fittings including jointing materials shall be stored within a clean dry storage area protected from extreme temperatures and where applicable in accordance with manufacturers recommendations.

UPVC

All pipework fittings, gaskets, and solvents shall be stored to avoid direct exposure to sunlight, and extreme temperature conditions.

Pipework shall be stored on level ground free from stones or sharp objects either on timber bearers 75mm wide and not greater than 1 meter centers and stacked neatly not more than 1 meter high, or alternatively stored in loose racks with side support not greater than 1.5 meters apart.

All fittings, gaskets and solvents shall be stored within a well-ventilated cool compartment, and retain in plastic bags and storage containers until ready for installation.

Pipe Sleeves

Where pipes pass through walls, or floors tubular pipe sleeves of non-combustible material shall be provided of sufficient size to permit the free passage of the pipe through the sleeve to ensure the pipe neither touches the sleeve nor the building structure.

All pipe sleeves shall be set in the walls, or floors before plastering or screeding is completed.

All sleeves shall be suitable for the pipe on which they are to be fitted and shall extend the full thickness of the division through which the pipe is to pass, after installation the gap between pipe and sleeve shall be "fire stopped" with suitable non-combustible caulking compound.

Where UPVC pipework passes through walls or floors a fire sleeve shall be provided tested in accordance with BS.476 comprising of a metal clad flanged sleeve with fire resistant filler rings in accordance with the detailed drawings.

Rainwater Roof Outlets (Roof Drain)

All rainwater outlets shall be cleaned to the satisfaction of the Engineer / Architect suitable for the specified pipe material.

Floor Gullies (Floor Drain)

Floor gullies and channel gratings shall be supplied and installed as required within public bathrooms and toilet areas and playgrounds. Where these are of a quality finish they shall be suitably protected until completion of the contract.

Where traps are suspended, they shall have weight support lugs cast on with suitable bracket fixing back to the structure.

FCO :	Floor clean out – 20 cm x 20 cm Chrome Plated, Ø 1100mm Bottom outlet
FD:	Floor drain – 20 cm x 20 cm Chrome Plated, Ø 75mm Bottom outlet
RD :	Roof Drain – 20 cm x 20 cm Chrome Plated, Ø 1100mm Bottom outlet

Waste Connections to Mechanical Services Plant

Waste and/or overflow connections from, pump glands, etc, shall discharge into a tundish and connect to drain via a trap connection or alternatively discharge over a trapped floor gully, but on no account connect to a soil pipe.

Overflows/Warning Pipes and Sanitary Fittings

All overflows and/or warning pipes shall be installed strictly in accordance with the Water Authority Bylaws/Regulations including any subsequent amendments, and the detailed drawings.

Depending on the location, the overflows and/or warning pipes shall discharge in the following locations and as indicated on the drawings.

a) External to the building
b) Over a Sanitary Fitting
c) Over the floor

Testing, Flushing Out and Cleaning of Soil, Waste, Vent and Rainwater Pipes

All pipework to be concealed shall be tested before being enclosed, a final test shall be made upon completion for soundness and performance strictly in accordance with the British Standard 5572, and include a simultaneous discharge test.

At completion of the installation all plugs shall be removed and the entire system flushed and rodded through.

CHAPTER THREE

PIPED SYSTEMS (LIQUIDS)

3.0 PIPED SYSTEMS (LIQUIDS)

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1. General

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3. Pipework service materials

4. Valves and cocks

5. Pipework ancillaries

6. Electrical Water Heater

7. Water storage tanks (P.E)

1. GENERAL

This section of the Specification shall apply to the following pipework installations:

Domestic Hot and Cold Water (including distilled and cold and hot soft water)

And as a supplement to the following sections:
Soil, Waste and Rainwater

Demarcations

The Domestic Hot and Cold-water service installation shall include final connections between isolation stop-cocks or valves serving sanitary appliances or equipment and the appliances/equipment being served.

2. PIPEWORK INSTALLATION (GENERAL)

Gradients and Erection of Pipework

Pipework shall be graded to ensure adequate draining and venting and wherever possible be self-venting. Draining and venting facilities as detailed in this Specification shall be fitted at all low and high points respectively and wherever else necessary to ensure that all sections and subsidiary sections can be drained and no air locks can form.

The gradients shall be in the direction of flow and shall be appropriate to the service as follows unless otherwise stated on the drawings:

Service	Gradient
All services	1 in 250

Pipework shall generally be set around all pipes and columns and shall follow the contours of the building whether so indicated or not.

Bare piping shall be erected so that there is 75 mm clear below it to the finished floor level and at least 25 mm to the finished wall face.

Insulated piping shall have sufficient clearance for the proper application of the insulating material. The finished surface of any covering shall be at least 25 mm from walls etc. Clearance between adjacent insulated pipes shall be at least 25 mm.

All pipework valves, fittings and equipment forming the piping installation shall be erected so that it can be dismantled and is accessible for repair and replacement.

Pipe and Services Supports

All pipework shall be supported by means of clips, hangers etc., or in the manner and positions indicated at intervals not exceeding the following:

Pipework O/D	UPVC

	Maximum Horizontal Support Distance m
25	1.0
32	1.1
40	1.1
50	1.2
63	1.4
75	1.6
110	1.9
125	1.9
160	2.1

In the event of two or more pipes being carried by a single support the spacing shall be for the short intervals. No more than two pipes may be supported from a single drop rod support. Double hanging of pipes with unequal expansion movement due to different service temperatures shall not be permitted.

All supports for mild steel pipes and fittings shall be ferrous as indicated and/or specified herein.

Metal pipe clips on plastic pipework shall be free of sharp edges likely to damage the pipe.

Valve supports shall be provided for all large diameter valves in plastic pipework to ensure that distortion of the pipework does not occur.

It shall be the responsibility of the Contractor to ensure that all supports are adequate, firmly and truly fixed, and that they do not transmit vibration.

The Contractor shall provide and install all fixings to the structure or cast in support channels where appropriate to carry the brackets, clips, hangers, etc., for the various services.

The Contractor shall provide all necessary steelwork for the support of the Services in vertical risers at the required intervals, which shall be detailed on drawings and submitted for approval. The drawing shall show full details of all steelwork sizes and fixings and shall show the imposed load from each service.

All pipework shall be supported by substantial brackets, hangers, or clips to the approval of the Engineer. The layout of piping shall take into account expansion and contraction, particularly at ends of runs where changes of direction occur. Main walls or partition walls etc., where pipes pass through sleeves shall not be considered as pipe supports.

Supports for insulated pipes on cold-water service shall be arranged so that there is no penetration by metal of the pipe insulation. In addition, precautions must be taken to preserve an unfractured vapor-proof skin at these joints. Two half sections of high-density phenolic foam (120 kg/m3) to fit the pipes and of correct thickness to suit the insulation shall be used at all support positions. The joints between the high-density phenolic foam and the insulation shall be chamfered and trowelled in with a mastic compound.

In exposed areas and where metal clad pipework insulation finish is provided the vapor barrier shall be over the band clip to ensure a concealed and straight line finish appearance.
When rested upon fixed supports, freedom of longitudinal movement must be provided.

Pipe Sleeves and Puddle Sleeves

Where pipes pass through walls, floors, footings and waterproof membranes, the Contractor shall include in his price pipe sleeves.

The inside diameter of sleeves shall not be less than 15 mm larger than the outside diameter of the pipe except where pipes pass through bearing walls or footings where sleeves shall be sized to allow for structural movement and 15 mm clearance from the outside diameter of the pipe.

The diameter of the sleeves for cold-water pipework shall be such that adequate clearance between the pipe and the sleeve will enable the insulation to be carried through the sleeve.

Sleeves shall protrude not less than 2 mm and not more than 4 mm proud of the finished surface.

Flushing of Pipework Systems

Prior to the chemical cleaning or treatment of any pipework system the entire system, sectionally or as whole, shall be subjected to a full-bore rapid flush to ensure the complete removal of any loose foreign material. This shall also apply to pipework systems where chemical cleaning is not called for.

The Contractor shall also be responsible for providing temporary fill and drain points on each system and for making whatever temporary arrangements that may be necessary to have adequate raw water available at the fill points and for the removal of flushing water from the drain points.

3. PIPEWORK SERVICE MATERIALS

Polypropylene (PPR) Pipes and Fittings

A. Polypropylene pipe shall conform to the following requirements:

- Polypropylene pipes shall be made of polypropylene, a copolymer RANDOM, Beta PPR with enhanced crystalline structure, Class-2 (S-3.2; SDR-7.4) for embedded domestic cold and hot water pipes applications. Beta PPR with Aluminum layer for exposed and embedded heating pipes, and for exposed cold and hot water pipes application conforming to EN ISO 15874 or approved equal International Standards (DIN, ASTM, ….) for polypropylene pipes.
- Polypropylene pipe: ASTM F 2389, pipe pressure rating shall comply with temperature and pressure ratings per the plumbing code requirement for the applicable service (water distribution, water service).
- Fittings shall have same material and quality as pipes and according to EN ISO 15874.
- Polypropylene Fittings: ASTM F 2389, socket fusion, butt fusion, electrofusion, or fusion

outlet fittings shall be used for fusion weld joints between pipe and fittings.

- Mechanical Fittings and transition fittings shall be used where transitions are made to other piping materials or to valves and appurtenances.
- Polypropylene pipe shall not be threaded. Threaded transition fittings per ASTM F 2389 shall be used where a threaded connection is required.

- Outer Layer (Optional)

  The base resin used for outer layer compounds shall be a base resin certified by the supplier to be compatible to the PPR resin/master batch that is used to produce the pipes.

  Colored outer layer compound shall be UV stabilized with minimum of 0.2 percent of a hindered amine light stabilizer (HALS).

- Anti-oxidant

  The percentage of anti-oxidant used shall not be more than 0.3 percent by mass of finished resin. The anti-oxidant used shall be physiologically harmless and shall be selected from the list given in IS 10909.

4. VALVES AND COCKS

General

All valves and cocks shall be generally as described and of first-class quality.

All castings shall be clean close-grained metal free from rough projections. Unless otherwise specified valves of 50 mm nominal bore and under shall have female ends screwed to BS 21 and valves 65 mm nominal bore and over shall have flanged ends.

Screwed valves shall have heavy hexagon reinforcements at openings, threads of ample length and heavy shoulders to prevent over entry to pipes. Flanged valves shall have the flanges flat faced on valves 50 mm and below and raised face on valves 65 mm and above and of thickness conforming to the appropriate Specifications and drilled.

All valves must have the maker's name or trade mark cast or heavily stamped or rolled on. Valves not bearing these distinguishing marks will be rejected.

Each valve must be made easy to operate before being installed.
Regulating and isolating valves shall be fitted to permit proper isolation and regulation of plant and primary and secondary mains.

All mains shall be provided with isolation valves at the point of entry or exit.

All valves shall be suitable for the fluid carried and the temperatures, test and working pressures of the system in which they are installed.

Where flanged ends are specified, the flanges shall be of the type and nominal pressure rating as specified in the 'Flanged Pipework Jointing' clause in this Section of the Specification.

Isolating Valves to Hot and Cold Water Services

(i) General

Isolating valves shall be installed in the locations shown on the drawings and on connections to single groups of wash-hand basins or wc's, on the draw-off connections to individual sinks and on connections to equipment.

(ii) Mains Water Services

Isolating valves on pipework size 54 mm and below shall be stopcocks of the screw down pattern gunmetal construction in accordance with BS 1010 with pinned jumper and gunmetal or brass spindle with crutch head and union connection.

Alternatively isolating valves were used internally shall be full way lever operated quarter turn spherical ball valves manufactured from dezincification resistant bronze, polished balls and PTFE seats. Ends shall be compression to BS864 Part 2 and the valve shall be suitable for working pressure up to 16 bar.

Servicing valves up to and including 22mm to be the spherical plug type manufactured to BS6675 with compression ends to BS864 and shall be chromium plated.

Valves above 54 mm shall be cast iron, with inside screw, wedge gate valves manufactured in accordance with BS 5163 Class 2, having flanged ends and provided with wheel head assembly unless otherwise noted on the drawings.

Alternatively valves above 54mm shall be butterfly valves to BS5155, lever operation, suitable for pressures up to 16 bar. Valves shall be approved for use on potable water services.

(iii) Cold Water Services

Full way gate pattern valves 54 mm diameter and below shall be bronze or gunmetal construction in accordance with BS 5154 solid wedge disc, non-rising stem, and having either integral solder ring capillary ring union ends, or compression ring joints in accordance with BS 864 Part 2.

Alternatively isolating valves were used internally shall be full way lever operated quarter turn spherical ball valves manufactured from dezincification resistant bronze, polished balls and PTFE seats. Ends shall be compression to BS864 Part 2 and the valve shall be suitable for working pressure up to 16 bar.

(iv) Hot Water Services

Full way gate pattern valves 54 mm diameter and below shall be bronze or gunmetal construction in accordance with BS 5154 solid wedge disc, non-rising stem, and having either integral solder ring capillary ring union ends, or compression ring joints in accordance with BS 864 Part 2.

Alternatively isolating valves were used internally shall be full way lever operated quarter turn spherical ball valves manufactured from dezincification resistant bronze, polished balls and PTFE seats. Ends shall be compression to BS864 Part 2 and the valve shall be suitable for working pressure up to 16 bar.

(v) Fitting Isolation Valves

Isolation valves to individual fittings shall be full port in-line spherical plug ball type of bronze or nickel construction, to BS 6675 with operating lever and compression ring joints in accordance with BS864 Part 2.

Ball Float Valves

Unless otherwise specified ball valves shall be of bronze or gunmetal construction manufactured in accordance with BS 1212, Part 1 and having a bronze or gunmetal seat, lever and plastic float conforming to BS 2456.

Where required ball valves of the delayed action type shall be provided generally as above and complete with hydraulic delay subsidiary tank and bottom float. Galvanized mild steel supports shall be provided to the valve manufacturers recommendations.

The ball valves shall be suitable for the particular pressure requirements at the point of discharge.

Hose Union Bib Taps

Hose Union Bib Taps shall be of the screw down pattern, gunmetal construction manufactured in accordance with BS 1010 and be complete with a bib hose union connection.

The bib taps shall have a polished finish and be complete with a polished brass dust bonnet.

Drain Cocks and Drain Valves

Drain cocks shall be fitted on all low points and on the 'dead' side of all isolating valves and cocks.

Other than on HTHW drain cocks where in exposed positions in rooms shall be of the bronze draining tap type to BS 2879 Type A with screwed end and lockshield dustcap. Elsewhere they shall be of the bronze gland cock type with hose union.

Drain cocks were used on hot, cold and mains water services shall be of the pattern that can be readily rewashered and that are suitable for 1.5 times the system working pressure.

Safety Valves

Safety valves shall be of the enclosed spring-loaded type complying with BS 6759 and of size not less than that required for the equipment specified. The safety valve shall be arranged vertically and attached directly to the equipment shell.

The safety valves shall have a padlock and key. Unless otherwise specified safety valve set pressure shall be:

1.1 x working pressure

The setting shall not exceed the design pressure of the equipment.

Safety valves up to 50 mm n.b. shall have screwed connections, bronze body, cadmium plated steel spring with high tensile brass adjusting screw and locknut suitable for a maximum working pressure of 24 bar.

5. PIPEWORK ANCILLARIES

Flow Commissioning Sets

Flow Commissioning Sets shall be provided on all main, branch and sub-circuits throughout the heating and chilled water pipework installations to enable satisfactory commissioning of hydraulic circuits. The sets shall comprise a measuring orifice ring with pressure tapings, fitted complete with valve. This valve shall be a double regulating valve in accordance with the appropriate Service Specification, located in the return pipe.

Orifice ring fittings 50 mm and below shall have gunmetal body castings with screwed ends to BS 21 and comply with BS 1400. Orifice ring fittings 65 mm and above shall have cast iron flangeless bodies with notches for pipe alignment fitted with stainless steel orifice plates and gunmetal retaining bushes.

Pressure tapings shall be the brass body mechanical self-sealing type with screwed blanking caps.

For flow rates below 0.04 liters /s low flow or ultra-low flow sets shall be provided, appropriate to the low flow rate condition.

Water Strainers

Strainers shall be located at inlets to control valve arrangements and pump sets and generally as detailed on the drawings.

The strainer shall be simplex or duplex as indicated on the drawings.

Each strainer shall be provided complete with a stainless steel strainer screen as follows:

Application	Perforation Size mm
In pipework 15mm to 50mm nominal bore and on inlets to all control valves.	0.8
In pipework 65mm to 100mm nominal bore.	1.2
In pipework 125mm nominal	1.6

bore and above.

Cold Water Applications, HWS and LTHW:

Strainers up to 50 mm shall be "Y" type of bronze or gunmetal construction in accordance with BS 5154 screwed ends to BS 21.

Pressure Gauges

Pressure gauges shall be 100 mm and 150 mm diameter as specified, aluminum alloy cased with chromium bezel Bourdon Type BS 1780, Part 2 and shall be with plain glass front, concentric pointer and red line at the working pressure scaled in bars.

The range, unless otherwise stated shall be a maximum of one and a half times the working pressure. The tubes shall be of brass construction and removable, and the outlet screwed BSPT.

Temperature Gauges and Wells

Dial type temperature gauges with aluminum alloy cases black painted with chromium bezel shall be fitted in the positions as indicated. Each dial type gauge shall be of mercury in steel type having a nominal dial size of 150 mm.

All gauges shall have a white dial with black numbering and shall be calibrated to cover the operating temperature range plus 30°C on DHWS and cold water.

Water Meters

Water meters shall be provided on the incoming water main and shall be located within an accessible position so as to facilitate easy reading and maintenance.

Meters for use on pipework over 40 mm diameter shall be of the in-line Helical Vane type with graphite iron body to BS 2789 1973 420/12, polypropylene rotor, stainless steel bearings, and shall be provided with flanged connections to BS 4504.

Each meter shall be provided with a suitable pulsed output suitable for connection to a central control and monitoring system.

All counters shall read in cubic meters.

All meters in exposed positions shall be suitable for the prevailing temperature conditions without loss of performance or accuracy.

Air Release LTHW, HWS, Oil

Air vents shall be fitted at all high points. Pipework which requires venting shall be fitted with 6 mm air cocks on air bottles. Air bottles shall be formed from 150 mm length of tube of equal bore to the pipe which is being vented, with 6 mm pipe welded into the top and taken to a low level accessible position unless otherwise specified and fitted with 6 mm lock shield needle valve. The discharge from the needle valve shall be piped to a convenient position for discharge into a container.

In addition, vent points on oil lines shall be provided with a mild steel receptacle hooked onto the piping and arranged to collect oil drips.

Automatic Air Vents

Automatic air vents shall be installed in accessible positions and shall be of aluminum bronze construction with brass spindle nickel alloy valve and seat, brass float and integral lock shield isolating valve. In all cases the air vent shall be preceded by a lock shield pattern stop valve and the discharge from the air vent shall be 10 mm copper pipe. Automatic air vents shall be provided on each service, with the exception of HTHW and MTHW, at the highest point of the service within each plant area and on each vertical distribution riser.

Discharge pipes shall be collected over a covered tundish and the outlet piped to the nearest drain gully. Discharge pipes shall be labelled according to the service.

6. ELECTRICAL WATER HEATER

Supply and install electric water heaters whenever shown on the drawings of capacities as indicated on the drawings.

Each electric water heater shall be of the cylindrical storage type constructed of heavy gauge steel with white enamel finish and glass lining from inside.

Heater shall have polyurethane foam insulation wall between the outer casing and the glass lining all around top and bottom of cylinder. Heater shall be suitable for a working pressure of 100 psi (690 Kpa).

Each electric water heater shall be complete with the following:

- Fast acting surface mounted thermostat for automatic temperature control.

- Factory installed sensitive high limit energy cut-off (for safety to prevent overheating) present at 210 °F (99 °C).

- Electric element of 1500 watt capacity and smaller as indicated on the drawings. Element shall be constructed of highest quality resistant wire sheathed in mineral filling and the whole encased in a copper tube and subjected to a high voltage test.

The water Supply System shall consist of piping, valves, automatic controls, tanks, electric water heaters, and all equipment as hereinafter specified and shown of the Drawings.

7. WATER STORAGE TANKS

Polyethylene Water Tank (s)

Polyethylene water tank(s) shall be of the size and shapes as indicated on the drawings.

All elements of the tank(s) and their appurtenances shall be designed to withstand all conditions of the intended service without undue stress or deflection. The design shall take into account the

stressed caused by the contents of the tank. The minimum allowable thickness of any portion of the tank(s) and their appurtenances shall be 7 mm, which shall be increased as necessary to provide adequate strength and shall be fully insulated to minimize heat gain.

The tank(s) shall be provided with reinforced threaded openings for all pipe connections and float switches indicated on the Drawings.

The top of tank(s) shall be equipped with a removable cover. The cover shall have a whole cur for the fill.

Interior and exterior surfaces shall have a relatively smooth texture.

CHAPTER FOUR
SANITARY FIXTURES

4.0 SANITARY, FIXTURES

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1. General

2. General Requirements

3. Sanitary Fixtures

4. Exposed Piping and Trim in Toilet Areas

5. Fixture Setting

6. Water Closet

7. Lavatory

8. Sinks

9. Bathrooms Accessories

10. Execution

1. GENERAL

The Sanitary Fixtures Work shall consist of installing, testing and putting in operation all Sanitary Fixtures, accessories, pipe fittings and equipment as here in after specified and as show on the drawings.

2. GENERAL REQUIREMENTS

- All fixtures and trimmings, in so far as practicable, shall be of one manufacture.
- Ample application of petroleum jelly shall be made to all surfaces of exposed chrome plated piping, valves and fittings immediately after installation
- All fixtures shall be set straight and true.
- Concealed brackets, hangers and plates shall have a shop coat of paint.
- All exposed piping and trim shall be chrome plated and fully protected during installation.
- Strap or padded wrenches shall be used on chrome plated pipefittings and valves.

3. SANITARY FIXTURES

- Sanitary fixtures shall be complete with all required trimming, including mixers, waste plugs or flow waste, traps, supplies, stop valves, escutcheons, casings and all necessary hangers, plates, brackets, anchors and supports.
- Vitreous china fixtures shall be of first quality with smooth glazed surfaces, free from warp, cracks, checks, discolorations or other imperfections.
- Enamelled cast iron fixtures shall be of acid - resisting type.
- The selection & approval of sanitary fixtures and their accessories & manufacturers is decided by the Client and or/his Representative

4. EXPOSED PIPING AND TRIM IN TOILET AREAS

All piping, valves and fittings exposed to view shall be screwed, polished, chrome plated brass. Plating shall be accomplished after threading.

5. FIXTURE SETTING

Fixtures shall be set in a neat, finished and uniform manner making the connections to all fixtures at right angles to the wall, unless otherwise directed by the Engineer. Roughing for this work must be accurately laid out so as to conform to finished wall material. Fixtures are not to be set until so directed by the Engineer.

The location and disposition of all items shall be as indicated on the relevant drawings.

All fixtures and fittings shall be as detailed in the schedule of fixtures, indicated on the drawings.

6. WATER CLOSET - Type EWC

White vitreous china, dual flush, water closet with wall outlet, syphonic action. EWC shall be complete with the following fittings:

WC pan with side outlet, cistern of 6 liters capacity for bottom supply and overflow with plastics syphon fitting, flush valve and mechanism, HP/LP bottom supply ball valve with refill unit, ¾ in bottom overflow, servicing valve and close coupling fitment (cistern fittings are not reversible), and chrome plated side lever, seat and cover, screws (pair), Plastic outlet connector for connection to 102 bore soil pipe. System shall be completed with flushing hose.

7. LAVATORY

White vitreous china lavatory shall be mounted basin into granite or marble vanity top and complete with the following fittings: 1 taphole, mixer, 1 ¼ in bead waste, 1 ¼ in chrome bottle trap with 75mm seal concealed bracket with fixing clamps in aluminum alloy & servicing valve.

8. BATHROOMS ACCESSORIES

Refer to Architecture BOQ and Specifications.

9. EXECUTION

Fixture Joints

Joints shall be standard fittings furnished with the fixtures. Where space conditions will not permit standard fittings, special short-radius fittings shall be provided.

The fixture joints on soil pipes shall be made absolutely gastight and watertight.

Strainers and Fixture Outlets

Lavatory basins shall have waste outlets not less 30mm in diameter. Wastes may have open strainers or may be provided with stoppers.

Shower-receptacle waste outlets shall be not less than 50mm in diameter and have removable strainers.

Sinks shall be provided with waste outlets not less than 40mm in diameter. Waste outlets shall have open strainers or shall be provided with stoppers.

Fixture Supports

Wall hung plumbing fixtures not supported on chair carries shall be supported on wall hangers on screw bolts furnished with the fixtures.

Where appearance of the bolts is not objectionable, the fixture shall be fastened to the wall by through-joint bolts. Bolt heads or nuts shall be hexagonal and painted or chromium-plated, and washers shall be painted or chromium-plated to match bolt heads or nuts.

Where appearance of bolt heads or nuts is objectionable, fixture shall be fastened to walls by machine-bolt expansion shields or stud-type expansion bolts.

Fixture Traps

Sanitary fixtures, excepting those having integral traps, shall be separately trapped by a water-seal trap, placed as close to the fixture outlet as possible.

The trap shall be of the same diameter as the fixture drain to which it is connected.

The fixture trap shall have a uniform interior and smooth waterway.

Each fixture trap shall have a water seal of not less than 60mm.

Fixture trap, except those integral or in combination with fixtures in which the trap seal is readily accessible or except when a portion of the trap is readily removable for cleaning purposes, shall have accessible brass trap-screw of ample size.

Cleanouts on the seal of a trap shall be made tight with threaded element plug and approved washer.

No fixture shall be double trapped.

CHAPTER FIVE

THERMAL INSULATION

5.0 THERMAL INSULATION

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Products

1. PIPEWORK THERMAL INSULATION (Type A)

A. Material

1. Thermal insulating material shall be made from long, fine fiber glass, Rockwool, free from short or coarse fibers, bonded with a temperature resistant binder and formed into a cylindrical or semi-cylindrical rigid pipe section with aluminum foil facing as described in duct insulation of thickness as specified below with a thermal conductivity of not greater than 0.05W/m•C. Insulation exposed on roof tank and in Mechanical Rooms shall have a density of 96 kg/m3. Insulation in false ceiling voids and shafts shall have a density of 48 kg/m3.

2. Thickness of Insulation

DOMESTIC HOT WATER SUPPLY AND HEATING WATER PIPES

NOM-BORE MM	THICKNESS MM
15-32	25
40-100	30
125	40
150 & above	50

3. The insulation shall have an alkalinity of between PH6.0 and PH10.0. Then insulation shall not include substances which will promote corrosive attack on the services with which it is to be in contact. The insulation shall also be free from objectionable odor at the temperature at which it is to be used, unable to encourage pests or support the growth of fungi, or suffer deterioration under the specific conditions of use or as a result of contact with moisture due to thickness, uniformity of thickness and internal diameter from manufacturer's standards dimension are as follows:

Thickness:	+ 3 mm
Uniformity of thickness	the local thickness at any point shall not differ from the average thickness by more than 3 mm.
Internal Diameter:	-0+1.5 or 1%, whichever is the greater

Pipe Fittings Insulation

- Where hangers are installed on the pipe covered with insulation, the entire hanger up to the rod shall be insulated.
- Where insulated piping is subject to movement and supported on rollers and chairs, or sliding plate brackets, steel protection saddles shall be provided.
- All insulated pipework not supported as described in Section 15060 but subject to movement, shall be provided with protection shields at all hanger locations. Shields shall be No. 10 gauge galvanized iron extending on each side of the hanger for a distance equal to the diameter of the insulation and shall be provided with cork pad support.
- Insulate valves, strainers, fittings and flanges with identical material, density, thickness and finish as the pipe insulation. Use premoulded material where available, otherwise use shaped block segments wired on with all edges filled with insulating cement or filler.

- Insulate strainers to permit removal of the basket without disturbing the insulation of the strainer body.

2. PIPEWORK THERMAL INSULATION (TYPE B)

This type of insulation shall apply to domestic hot water system under tiles or in walls.

Pipes shall be insulated with rubber type insulation Armaflex 19 mm thick. Insulation shall be closed sell tubing with finished skin, chemical and oil resistant with minimum water absorption. Insulation shall stand extremes temperatures ranging from 40ºC to 120ºC. Inner tubing insulation diameter shall be equal to outer utility pipe diameter. Rubber insulation shall be wrapped with 2 layers of PVC tape.

Insulation density shall be 0.111 Gms/m3 with thermal conductivity K value at 40ºC mean temperature 0.041 W/M-K insulation shall be self-extinguishing.

Insulation shall be ASTM approved similar to Gulf – O – Flex or approved equal.

CHAPTER SIX

HVAC

6.0 HVAC

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1. Inlet and outlet terminals

2. Fans

1. INLET AND OUTLET TERMINALS

1.1 Grills

The Contractor shall select and locate the grilles and diffusers and coordinate them into the architectural reflected ceiling plans where applicable.

During construction the Contractor shall co-ordinate the location and fixing of the grilles and diffusers with the ceiling installations. The Contractor shall site measure and agree with the Engineer the final dimensions of all grilles and diffusers before manufacture.

2. FANS

2.1 General

The Contractor shall supply and install in accordance with this Specification, fan and motor assemblies as detailed in the Schedules of Equipment and as indicated on the drawings.

Fan unit performance curves derived in accordance with BS 848 shall be supplied showing volume, static pressure, maximum absorbed kW and static efficiency with the unit operating condition clearly marked. These details shall be issued to the Engineer for approval prior to the fans being installed.

A sound spectrum for each fan and motor assembly derived in accordance with BS 848 shall be supplied to the Engineer before manufacture, but under no circumstances shall the sound power level exceed that given in the Schedule of Equipment.

Additional attenuation is specified in the Schedules to meet specific noise criteria for fan systems. Where fans are supplied having different sound spectrum or ductwork is modified, the attenuator insertion losses shall be adjusted to ensure design noise criteria are maintained.

The fan motors shall comply with the relevant clauses on Electric Motors set down elsewhere in this Specification.
Unless otherwise specified or detailed each fan assembly shall be installed on a 150 mm concrete base and shall be isolated from the structure by anti-vibration mountings in accordance with the relevant clauses of this Specification.

The complete fan assembly shall be primed and painted in a color to be agreed with the Engineer and in accordance with the relevant section of this Specification relating to painting.

Each fan shall be isolated from the ductwork installation by flexible connections complying with the relevant clauses set down elsewhere in this Specification.

2.2 Axial Flow Fans

Axial flow fan impellers shall be of the multi-blade type dynamically balanced with blades of 'aerofoil section' constructed from aluminum alloy.

The casings shall be of the long type of heavy gauge mild steel having flanges at both ends and hot dipped galvanized to BS 729 after manufacture.

The casings shall be provided with bolted inspection doors and an external weatherproof terminal box.

The impellers shall be direct driven by motors of totally enclosed continuously rated 3-phase type with ball bearings and extended grease point. The impellers shall be capable of giving fan total efficiency of not less than 75%.

Purpose made feet shall be provided on the fan casing for supporting the fans.

The fan speed shall not exceed 24 rps (1440 rpm).

Each axial flow fan shall be supported by means of a strong rolled steel angle or channel frame from the steelwork, wall or floors as necessary.

CHAPTER SEVEN
HEATING SYSTEM

1. Diesel Boiler

Type: floor-standing.

Capacity and Performance:
- Heating Capacity: **30 kw & 50 kW**
- Efficiency: ≥ 90% (low-temperature systems).
- Operating Temperature: 30°C to 70°C.
- Fuel Type: Diesel (low sulfur grade preferred).

Material and Construction:
- Heat Exchanger: Stainless steel (SS 316L) or cast iron for corrosion resistance.
- Burner: Fully modulating diesel burner for efficiency.
- Combustion Chamber: Insulated with ceramic fiber for thermal efficiency.

Control Features:
- Integrated thermostat for temperature control.
- Programmable timer and fault diagnostics.
- Safety features: Flame failure device, over-temperature protection, and low-water cut-off.

Standards and Compliance:
- **EN 303-1**: Heating boilers.
- **ISO 23553-1**: Automatic burners for liquid fuels.
- **CE Marking**: Ensures compliance with European directives.

2. Heating Pumps

Type:
- Circulator pump for hot water distribution to radiators.
- Inline or wet-rotor pumps, depending on system design.

Specifications:
- Flow Rate: **As per drawings & B.o.Q**
- Pressure Head: **As per Drawings & B.o.Q**
- Motor: Energy-efficient, EC motor (IE3 or higher).
- Operating Temperature: Up to 110°C.
- Speed Control: Variable speed with pressure control.

Material:
- Pump Body: Cast iron.
- Impeller: Stainless steel.

Compliance:
- **EN 733:** Pumps for water installations.
- **ISO 9906:** Hydraulic performance acceptance tests.

3. Pipes and Fittings

Material: PPR
Size and Pressure Rating:
- Diameters: DN 20 to DN 40 (as per system design).

- Pressure Rating: PN 16 minimum.

Accessories:
- Isolation valves, check valves, and air vents at high points.
- Dielectric unions for connections between dissimilar metals.

4. Insulation

Type:
- Flexible elastomeric rubber foam insulation (closed-cell).

Thickness Recommendations:
- **Heating Pipes (Hot Water):** 50 mm

Density and Properties:
- Density: 48 kg/m³.
- Thermal Conductivity: ≤ 0.035 W/m·K at 20°C.
- Fire Rating: Class 1 or Class O (BS 476).

Compliance:
- **EN 14304**: Thermal insulation products.
- **ASTM C534**: Preformed elastomeric thermal insulation.

5. Radiators

Type:
- Panel radiators (single or double panel).
- Column radiators for aesthetic or higher heat output.

Material:
- Aluminum radiators: Lightweight with high thermal conductivity.

Size and Heat Output:
- Fin Height: 580 mm.
- Number of Sections: Based on heat load calculations.

Valves and Controls:
- Thermostatic Radiator Valves (TRVs) for individual room control.
- Manual air vents for each radiator.

Standards:
- **EN 442-1**: Radiators and convectors.
- **ISO 9001**: Quality management for manufacturing.

6. Diesel Supply System

Diesel Transfer Pump:
- Flow Rate: 10L/min.
- Type: Positive displacement or centrifugal pump.

Fuel Lines:
- Material: Black steel with threaded or flanged connections.
- Compliance: **BS EN 10255** (underground fuel pipes).

7. Controls and Monitoring

Central Control Panel:
- Boiler control integration.
- Pump operation sequencing.
- Temperature monitoring for flow and return lines.

Sensors:
- Outdoor temperature sensor for weather compensation.
- Flow temperature sensors for boiler modulation.

Safety Features:
- Pressure relief valve.
- Automatic shutdown in case of overheating or fuel failure.

8. Testing and Commissioning
1. **Hydrostatic Pressure Test:**
    - Conduct at 1.5 times the operating pressure.
2. **Thermal Performance Test:**
    - Verify temperature consistency across all radiators.
3. **Fuel System Testing:**
    - Ensure no leaks in the diesel lines and proper fuel delivery to the boiler.

9. Documentation and Certifications
- Detailed system layout drawings.
- Equipment datasheets and material certificates.
- Operation and maintenance manuals.
- Warranty: Minimum 2 years for system components.

PART 3

ELECTRICAL SPECIFICATIONS

VOLUME 2
SPECIFICATIONS

PART 3
ELECTRICAL ENGINEERING SERVICES

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CHAPTER 1
BASIC ELECTRICAL REQUIREMENTS

1 - GENERAL

1.1. RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this and the other chapters of part 3.

1.2. SCOPE OF WORK

1.2.1 The scope of electrical work for the Project will include but is not necessarily limited to:

A. Power Supply and Distribution consisting of:
- Sub-distribution and final branch circuit panelboards,
- Cables, wires and related accessories,
- Conduits, wireways, supporting systems and related accessories,
- Earthing system.

B. Lighting and Power Installations including:
- Functional indoor and outdoor lighting installations,
- Wiring devices including all lighting switches, isolating switches, socket - outlets, plates,

1.2.2. Unless otherwise specified, includes the supply, installation, testing and commissioning of the complete electrical systems, equipment and materials shown on the Drawings and/or described in the Specification together with all associated ancillary work, support work and builder's work in connection.

1.2.3. Incoming power supply and connection will be provided by the Local Power Authority at 220/380 V to the location shown on the Drawings.

1.3. GENERAL REQUIREMENTS

1.3.1. INSTALLATIONS GENERALLY:

A. Carry out electrical work in accordance with the Drawings, Specification and Regulations, ensuring compliance with design and performance requirements, to provide safe and protected systems with equipment readily accessible for operation, maintenance and repair

B. Installations are to be complete, ready for operation and fully integrated and coordinated with all other work

C. Installations are to be carried out by qualified personnel

D. Provide accessories necessary to complete the installations, of the types specified or recommended for the purpose by the manufacturer of the equipment or accessories.

1.4. DESIGN CONDITIONS

1.4.1. Nominal characteristics of power supply and distribution are as follows:

A. low voltage : 380 V, 3 phase, 4 wire, solidly earthed neutral

B. frequency : 50 Hz.

1.4.2. DISTRIBUTION SYSTEMS are to be supplied or derived from the voltage system previously described, as shown on the Drawings, or as otherwise specified.

1.4.3. EQUIPMENT is to be designed for the system voltage and frequency previously described, unless

otherwise specified. Special provisions are to be made for equipment sensitive to power supply frequency and voltage variations and for equipment operated at other voltages/frequencies or by direct current sources.

1.4.4. CLIMATIC CONDITIONS: equipment, including transformers, switchgear, cables, relays, lighting fixtures, motors etc., is to be designed and derated for continuous and trouble-free service under the following climatic conditions:

A. altitude : at sea level

B. maximum ambient temperature: 40 deg. C (in the shade)

C. minimum ambient temperature: 4 deg. C

D. maximum relative humidity: 90 %

E. atmospheric conditions: 1 bar

Where design and operating conditions, different from the above are required for particular equipment, they are described in the specification of the equipment concerned.

1.4.5. REGULATIONS: carry out electrical work in accordance with the current issue of the local codes of practice, local power authority regulations and IEC Regulations for Electrical Installations, where not in contradiction with the local codes of practice and regulations, herein referred to collectively as 'the Regulations'.

1.4.6. STANDARDS: unless otherwise specified, equipment and materials are to be manufactured and installed in compliance with the relevant recommendations of the following:

IEC	:	The International Electro-technical Commission
ISO	:	The International Standardization Organization
EN	:	European Norm
NF-USE	:	The French Regulation
BS	:	British Standards

or other equal and approved standards, herein referred to as 'the Standards'. Local standards, where enforced and relevant, are to have precedence over the Standards.

1.5. EQUIPMENT AND MATERIALS

1.5.1. AVAILABILITY: confirm availability of equipment and materials proposed for use in the work prior to submission for approval. If, after approval, equipment or materials cease to be available, submit alternative items of equal quality and type for approval.

1.5.2. ACCEPTANCE BY AUTHORITY: confirm that proposed equipment and material characteristics where required are compatible with the requirements of the Local Power Authority or other authorities having jurisdiction and are acceptable to them. Inform the Engineer of any modifications necessary to comply with the Local Power Authority's requirements.

1.5.3. MANUFACTURERS' STANDARDS: equipment is to be the latest standard product of the manufacturer. Component parts are to be the product of a single manufacturer, unless otherwise approved and provided that components made by other manufacturers are of a standard design and are interchangeable.

1.5.4. APPROVED MANUFACTURERS: listing of approved manufacturers in the Specification does not necessarily constitute approval of their standard products as equal to those specified. As certain that listed manufacturers are able to supply equipment and material in conformity with the Specification.

1.5.5. LABEL AND IDENTIFY all equipment, instruments, control and electrical devices etc. to indicate duty, service or function, to the satisfaction of the Engineer. Labels are to be laminated plastic or anodized aluminum discs with black surface and white core with incised lettering in English or Arabic to the satisfaction of the Engineer. Alternative methods of labelling may be submitted for approval. Fix labels

with non-corrodible screws to equipment, or to adjacent permanent surfaces or as approved by the Engineer.

1.5.6. EQUIPMENT NAMEPLATES are to be non-corroding, robust metal, inscribed in English, and firmly fixed to equipment at factory. Nameplates are to indicate name and address of manufacturer, model, serial number, basic characteristics and ratings of equipment and are to include elementary diagrams etc., all in accordance with the Standards.

1.6. SUBMISSIONS

1.6.1. GENERALLY: submit for approval, manufacturers' technical literature, shop and construction drawings and other information required by the Specification, before ordering equipment or materials and before executing any related work on site.

1.6.2. TECHNICAL LITERATURE is to include detailed manufacturers' specifications and original catalogues or catalogue cuts, characteristics, model number, application and operating criteria of all equipment and materials, together with other information necessary to satisfy the Engineer that proposed equipment and systems are suitable and adequate.

1.6.3. SHOP AND CONSTRUCTION DRAWINGS are to demonstrate to the Engineer that the design requirements are understood by indicating all equipment and material proposed to be supplied and installed and by detailing fabrication and installation methods proposed to be used. Shop and construction drawings are to clearly state the name and location of the work, the names of the Engineer and Contractor, submission date, cross-references to the Drawings and Specification and the specific reference number, location, service and function of each item.

1.6.4. LIST OF PROPOSED MANUFACTURERS of all equipment and materials, including all items for which choice of manufacturer is at the discretion of the Contractor, is to be submitted for approval.

1.6.5. TEST CERTIFICATES AND REPORTS: where required by the Specification, submit manufacturer's type and routine test certificates and reports for equipment and devices. Complete test results are to be submitted in clearly identified and organized booklets, indicating item of equipment, make, model, type, date of tests, type of tests, descriptions and procedures.

1.6.6. LABORATORY TESTS: if manufacturer's test certificates are considered unsatisfactory, then independent laboratory tests are to be carried out on equipment in accordance with the Specification and the Standards, as required by the Engineer.

1.6.7. SPARE PARTS SCHEDULES: submit with the Tender itemised schedules of spare parts to be provided, as required by the Specification, and state against each item the manufacturer's unit price including packaging and delivery to site.

1.6.8. TOOLS AND INSTRUMENTS SCHEDULES: submit with the Tender itemized schedules of tools and instruments to be provided, as required by the Specification, and state against each item the manufacturer's unit price including packaging and delivery to site.

1.6.9. LABELLING SCHEDULE: submit for approval, prior to installation, a schedule of all equipment and devices to be labeled and the suggested details, lettering, position and fixing methods of each label indicating its application.

1.6.10 SAMPLES: submit samples of all equipment and materials for approval. Major items of equipment for which samples cannot be submitted are to be demonstrated in existing installations or by manufacturer's information, test certificates and reports.

2 - TESTS ON SITE, RECORDS, TRAINING AND MAINTENANCE

2.1. TESTS ON SITE

2.1.1. GENERALLY: carry out inspection and acceptance tests on site on each complete system, before final placement into service, in accordance with the Regulations and Standards, as described in the

Specification and required by the Engineer.

2.2. RECORDS

2.2.1. GENERALLY: not later than the date of substantial completion, provide the Engineer with four copies of all approved as-installed drawings, test records, manufacturers' guarantees and warranties, operating and maintenance manuals and other records required by the Specification.

2.2.2. OPERATING AND MAINTENANCE MANUALS are to contain the following:

A. Technical description of each system and item of equipment installed, written to ensure that the Employer's staff fully understand the scope and facilities provided.

B. Schedules (system by system) of equipment installed giving manufacturer, catalogue list numbers, model, rating, capacity and operating characteristics; each item is to have a unique code and number, cross-referenced to the diagrammatic drawings and layout drawings.

C. Manufacturers' lists of recommended spare parts for items subject to wear and deterioration, giving expected running period and indicating specifically those items which may involve extended deliveries.

2.3. MAINTENANCE

2.3.1. MAINTENANCE CONTRACTS: where required by the Specification, submit supplementary proposals for annual maintenance contracts. The proposals are to:

A. include for maintaining the installations in efficient working order including routine and emergency service checks, adjustments, lubrication and the supply and replacement of damaged parts etc.

B. set out the terms of the offer, the work to be carried out, the guarantees of performance and the price of the work or part thereof for the first twelve months after substantial completion.

The proposals will not be considered as part of the Tender.

CHAPTER 2
DISTRIBUTION, SUBDISTRIBUTION AND FINAL BRANCH CIRCUIT PANELBOARDS AND ATS

1. GENERAL

4.1 ELECTRICAL WORK GENERALLY is to be in accordance with the requirements of the chapter1 of the Specification.

4.2 DESCRIPTION OF WORK: panelboards for distribution and sub distribution of electric power and for protection of circuits, including fixing and supporting materials and materials for termination of feeders, sub-circuits and branch circuits.

4.3 STANDARDS: panelboards generally are to comply with the requirements of IEC EN 60439-1, Factory-Built Assemblies of Low Voltage Switchgear and Control Gear. Exceptionally, they may not be factory-built nor type tested.

4.4 DESIGNATIONS: panelboards are designated on the Drawings and in the Schedules as follow:

1. Final branch circuit panelboards, power panelboards and subdistribution panelboards respectively, for secondary lighting and power distribution with either miniature circuit breaker (MCB) or moulded case circuit breaker (MCCB) protection on subfeeder or branch circuits, as shown on the Drawings.

4.5 EQUIPMENT DATA: submit data for approval including, but not limited to, the following:

1. Manufacturers' catalogues indicating specific equipment selected.

2. Types of panelboards and circuit breaker characteristics including duties and ratings compensation at and above 40 deg. C ambient conditions and corresponding temperatures within the enclosures.

3. Dimensions of panels and specific contents of each panelboard.

4. Integrated equipment tabulations for coordinated short- circuit series combinations of circuit breakers (cascading and discrimination).

4.6 TESTS AND CERTIFICATES: submit complete certified manufacturer's type test and routine test records in accordance with the Standards.

4.7 APPROVED MANUFACTURERS: obtain panelboards from one of the following:

1. Merlin Gerin, Telemecanique (Schneider) (France)
2. Klockner Moeller (Germany)
3. ABB (Germany)
4. Siemens – ITE (Germany)
5. Legrand (France)

2. PRODUCTS AND SYSTEMS

2.1 DISTRIBUTION, SUBDISTRIBUTION PANELBOARDS

2.1.1. GENERAL REQUIREMENTS

A. RATED INSULATION VOLTAGE is to be in accordance with the respective Standards.

B. PANELBOARDS are to be totally enclosed, dead front type, protection code IP 42 for indoor installations and IP 55 for outdoor installations, in accordance with IEC 529, and are to be factory designed and assembled.

C. EARTHING BAR is to be provided in every panelboard.

D. PROTECTION is to be fully rated throughout the systems.

E. CIRCUIT BREAKERS are to be non-fused type.

2.1.2. PANELBOARD ENCLOSURES

A. TYPE: general purpose type, suitable for relevant ambient conditions, flush or surface mounted as shown on the Drawings, comprising box, trim, or trim and door to approved manufacturer's standards and sizes.

2.1.3 BUSBARS

A. TYPE: one piece, 98% pure electrolytic copper, based on maximum total temperature rise of 20 deg. C over an ambient of 40 deg. C at full continuous rating. Bolted contact surfaces are to have maximum current density not exceeding requirements of the approved standards. Aluminum is not to be used for busbars or panelboard parts.

B. DESIGN: busbars are to be shrouded/insulated and rigidly designed so that branch circuit devices can be removed without disturbing adjacent units or changed without additional machining, drilling or tapping. Busbars are to be full size without reduction. Busbar System and blank plates are to allow installation of future circuit devices, where indicated on the Drawings.

C. NEUTRAL BAR is to be solid and fully insulated from cabinet or box. One solder-less box type set-screw connector is to be provided for neutral wire of each branch circuit and one bolted clamp-type connector or anti-turn lug with set-screw for main incoming neutral wire. Neutral is to be fully sized and rated as for phase busbars.

D. EARTHING BAR is to be copper, brazed to panelboard cabinet, with bolted pressure connector for main conductor and one set-screw-type tunnel terminal for each outgoing conductor, to provide secure and reliable contact with all metal parts and enclosure.

2.1.4 MOULDED CASE CIRCUIT BREAKERS (MCCBs)

A. TYPE: tested to approved standards, totally enclosed, moulded case, constructed from high quality, high temperature resistant, tropicalized, moulded insulating materials, for normal operation at maximum temperature within enclosures at point of application, and provided with front operated single toggle type handle mechanism for manual operation of main contacts in addition to automatic operation under overcurrent and short circuits conditions. Multi-pole breakers are to have common integral trip bar for simultaneous operation of all poles. Ampere rating is to be clearly visible. All terminals are to be box lug or clamp type with set screws, suitable for copper or aluminum.

B. MCCBs FOR SDB: To comply with IEC947-2 test sequences I, II, III, utilization category A, and are to have rated service short circuit breaking capacities to meet the electrical requirements at the panelboard location.

C. FRAME SIZE is defined as maximum continuous current rating of circuit breaker which corresponds with its maximum trip range and which is to be related to minimum acceptable short-circuit interrupting ratings, based on fully rated interrupting duties: normal duty (N), high break (H), or current limiting (L), as specified.

D. RESIDUAL CURRENT OPERATED EARTH LEAKAGE TRIP DEVICES (RCDs) are provided as add-on or built-in earth leakage accessories, where required and as shown on the Drawings. Protection against earth fault current, in addition to overcurrent and short-circuit protection, is to be in accordance with the Regulations. Trip current sensitivity on breakers for branch circuits is to be 30 mA, and for main breakers ratings are to be as shown on the Drawings. Circuit breakers are to include current transformer with tripping coil assembly, test button and trip free mechanism to ensure circuit breaker cannot be held closed against earth faults.

2.1.5 MINIATURE CIRCUIT BREAKERS (MCBs)

A. TYPE: thermal magnetic non-adjustable type, tested in accordance with IEC 947.2 & IEC 898. Breaker type and short circuit interrupting ratings are mentioned on design drawings.

B. MINIMUM SHORT-CIRCUIT BREAKING CAPACITIES are to be as shown on drawings. Contractor to check and confirm those levels (according to final equipment location: Transformers, MDBs, Panel Boards,….)

C. CONSTRUCTION: MCBs are to be tropicalized for operation at ambient temperatures up to 70 deg. C within panelboard enclosure and humidity up to 95%, and are to be constructed from high quality, high temperature, moulded insulating materials. Guaranteed duties and characteristics are to be submitted for temperatures above 40 deg. C. MCBs and combinational devices are to be modular, of unified profile and mounted to a standard DIN rail.

D. OPERATION: under overload conditions, thermal tripping is to provide close protection of insulated conductors. Under short-circuit conditions, magnetic trip is to operate at 5-10 times normal rated current (curve C characteristic). Magnetic operation is to be in the current limiting region and opening time is not to exceed 5 milli-seconds.

E. RATINGS: preferred rated currents are to be 6, 10, 16, 20, 25, 30, 40, 50, 60, 80 and 100 A, calibrated at 40 deg.C, available as 1+N, 2, 3 and 4-pole circuit breakers. Derating above 40 deg. C is not to exceed 1% per deg.C, and loading is not to exceed 70% of circuit breaker rating.

F. RESIDUAL CURRENT DEVICES for earth leakage protective circuit breakers are to be add-on devices, or built-in and integral with the standard circuit breaker. Non-adjustable sensitivities of 30 mA, 100 mA and 300 mA are to be available for all ratings of 1+N, 2-pole and 4-pole circuit breakers.

2.2 PANELBOARDS

A. ARRANGEMENT: to comprise set of homogeneous branch circuit breakers with unified profile and base, and one main circuit breaker or switch (as shown on drawings). Circuit breakers or other devices are to occupy modular spaces. Accommodation of contactors and split-bus arrangement or other devices is not to change regularity of standard box width.

2.2.1. FINAL BRANCH CIRCUIT PANELBOARDS SDB- TYPE MCB

A. INTERNAL ASSEMBLY: to comprise removable back plate or back pan of rigid construction, attached to enclosure by four captive screws through keyhole fixings, and provided with DIN rails in horizontal arrangement for single and three phase panels. Assembly is to be complete with earthing bar and one piece insulated bolt-on/comb-type phase busbar. Busbars are to be single-phase and neutral or 3-phase and neutral with spade connectors for fixing by tightening a single screw on circuit breaker. Insulation is to be high thermal rating, capable of carrying maximum short-circuit current for one second without overheating beyond acceptable limits required by the Standards. Panelboards are to comply with NFC and IEC standards. If the busbars rating exceeds 100 Amp (where the frame size of the main breaker is larger than 100 Amps), comb busbars shall not be used but still clause 2.1.3. of this specification shall apply.

B. SINGLE PHASE TYPE PANELBOARDS are to be suitable for 240 V maximum service voltage, single-phase and neutral, with MCBs on branch circuits and main incoming.

C. SINGLE PHASE TYPE PANEL BOARD MAIN CIRCUIT BREAKER OR SWITCH DISCONNECTOR is to be double-pole, with or without earth leakage device (RCD), as shown on the Schedules.

D. SINGLE-POLE + NEUTRAL (1 + N) AND DOUBLE-POLE (2P) MCBs for 240 V service, are to have trip ratings between 6 A and 50 A, with ICU (n)/ICS as required in the Schedules.

E. THREE PHASE TYPE PANELBOARDS are to be suitable for up to 415 V a.c. maximum service voltage, 3 phase and neutral, with MCBs on branch circuits and 4 pole switch disconnect or circuit breaker, main incoming, as shown in the Schedules or on the Drawings.

F. FOUR-POLE BRANCH CIRCUIT BREAKERS are to have trip ratings between 6A and 100A, with ICU/ICS as required in the Schedules.

G. THREE PHASE TYPE PANELBOARD MAIN SWITCH DISCONNECTOR OR CIRCUIT BREAKER is to be four-pole, with or without earth leakage device (RCD), as shown on the schedules.

H. SHORT-CIRCUIT RATING: THREE PHASE panelboards may only have an integrated equipment (series) short-circuit rating in accordance with calculations.

3. FIELD AND INSTALLATION WORK

3.1 INSTALLATION

A. FIXING GENERALLY:
- Align, level and securely fasten panelboards to structure
- Fix surface mounted outdoor panelboards at least 25mm from wall ensuring supporting members do not prevent flow of air.
- Do not use connecting conduits to support panelboards
- Close unused openings in panelboard cabinets.

B. PANELBOARD INTERIORS: do not install in cabinets until all conduit connections to cabinet have been completed.

C. WIRING INSIDE PANELBOARDS: to be neatly arranged, accessible and strapped to prevent tension on circuit breaker terminals. Tap-off connections are to be split and bolted type, fully insulated. Wiring shall be arranged on terminals and connection blocks with marking as indicated in section 16120 of the specifications.

D. TRIM: fix plumb and square prior to painting. Fix trim for flush mounted cabinets flush with wall surface finish.

E. PROTECTION: treat concealed surfaces of recessed cabinets with heavy field application of water-proof compound prior to installation.

3.2. INSPECTION AND TESTS ON SITE

A. GENERALLY: carry out sample tests, as required by the Engineer, on panelboards after installation, to verify short-circuit capability of circuit breakers and busbars. Inspect conditions within panelboards and verify insulation conditions by use of a megger.

B. CIRCUIT BREAKERS: tests are to include operation of every circuit breaker manually. Check automatic operation of selected circuit breakers, as required by the Engineer, by applying necessary short-circuit, overload and earth leakage current for tripping circuit breaker as applicable and compare with manufacturer's data/characteristic curves. Measure and report ambient temperature inside enclosure.

C. INSULATION CHECK TESTS: carry out insulation tests on all busbars, between phases and between phases and earth/cabinet, and between neutral and earth. Record all readings, using 500 V megger for equipment on 240 V systems, and 1000 V megger for equipment on systems up to 600 V, for 1-minute, with circuit breakers in open position.

D. ROUTINE TESTS ON SITE are to be carried out, in accordance with the Standards, on all panelboards assembled from standardized components of the manufacturer outside the works of the manufacturer.

4. AUTOMATIC TRANSFER SWITCH (ATS)

GENERAL

Automatic transfer switches complete with all accessories shall be incorporated.

They shall be rated for continuous operation at the prevailing ambient temperature. They shall be rated for all classes of load both inductive and resistive. They shall be able to close on an inrush current up to and including 10 times the continuous rating of the switch and be capable of enduring 6000 cycles of operation at rated current at a rate of 6 cycles per minute without failure. The automatic transfer switch shall be interlocked to positively prevent the load from being simultaneously energized by normal and emergency power. Manual transfer switch shall also be possible.

A. ATS ACCESSORIES

Voltage sensors and time delays of 5 minutes or less shall be solid state, plug-in devices. The control relays shall be dust-covered, plug-in devices. These control accessories shall mount on a dead-front, swing-out control accessory panel to avoid shock hazard while adjusting control functions, but will swing- out exposing the wiring to facilitate servicing. A control Disconnect plug shall be provided to deenergize control circuits when control accessory panel is in the open, swing-out position. Indicating lamps and meters shall be set in a front mounted meter panel to be visible without opening doors.

B. EQUIPMENT AND OPERATION

Control accessories shall be provided to:

1. Monitor each ungrounded line with calibrated dial adjustable voltage, solid state sensors to sense a decrease of voltage below a set point, or a loss of voltage on any phase of the normal power source Voltage sensors shall be temperature compensated for 2 percent maximum deviation over the temperature range - 25°F (-32°C) to - 175 °F (+ 79°C).

2. Signal the engine - generator set to start in the event of a power interruption (a selected ATS). A solid-state time delay (adjustable from 0.5 to 10 seconds) shall delay this signal to avoid nuisance start-ups on momentary voltage dips or power outages.

3. Transfer the load to the engine-generator after it reaches proper voltage and frequency. A solid-state time delay (adjustable from 0.5 to 10 seconds) shall delay this transfer to allow the engine-generator to stabilize.

4. Re transfer the load to the line after normal power restoration. A time delay (adjustable from 0 to 30 minutes) shall delay this retransfer to avoid short-term normal power restoration.

5. Provide an automatic by-pass to retransfer the load from generating set to normal source if generating set output interrupts after normal source restores voltage.

6. Signal the engine-generator to stop after load retransfers to normal source. A solid-state time delay on stop (adjustable from 0.5 to 5 minutes) shall permit engine to run unloaded to cool down before shutdown (a selected ATS).

7. Provide a switch to select “with load” or “without load” to test or exercise as follows:

    a. “Without Load” the generating set runs unloaded.

    b. “With Load” the automatic transfer switch transfers load to generating set, after time delay, the same as it would for a normal source interruption.

8. Provide a device to electrically disconnect the control section from the transfer switch for maintenance service during normal operation.

9. Automatic Transfer switch shall be remotely actuated with the possibility of operating as automatic or manual transfer switch if the user wishes to.

10. Transfer switch shall be contactor type and shall be rated to carry 100% of rated current continuously in the enclosure.

11. Transfer switch shall have arc chutes of heat absorbing material and metal leaves for positive extinguishing of areas. Arc chutes shall have insulating covers to prevent interphase flashours.

12. The complete transfer shall be enclosed in a non-ventilated IP40 enclosure for installation indoors. The enclosure shall contain a swing out service panel and a key operated door lock.

C. METER AND LAMP COMBINATION

Indicating meters and lamps shall be front mounted for easy reading without opening doors. Meter and lamp combination shall provide.

1. Green (normal) and red (emergency) indicating lamps to indicate which source is supplying power to the load.

2. AC Voltmeter to measure generator output voltage.

3. AC Voltmeter, frequency meter with pointer indicator and running time to monitor electric generating set.

CHAPTER 3
CONDUITS, WIREWAYS, SUPPORTING SYSTEMS WIRES & CABLES AND RELATED ACCESSORIES

1. GENERAL

1.1. ELECTRICAL WORK GENERALLY: is to be in accordance with the requirements of the chapter 1 of the Specification.

1.2. DESCRIPTION OF WORK: raceways including conduits, wireways, cable trays and related installations and accessories necessary to support and protect cables, feeders, branch circuit wiring and wiring of low current systems, communications and signal cables.

1.3. REGULATIONS AND STANDARDS: conduits, wireways, cables trays and fittings are to be designed, constructed and installed to give safe installation and reliable mechanical protection for wires and cables in accordance with the Regulations. Standards of products are to be as specified. Local production is prohibited if not tested and approved by a legal authority.

1.4. TECHNICAL DATA: submit data for approval including, but not limited to, the following:

A. Manufacturer's catalogues with specifications of raceways including conduits, trunking etc. and related accessories.

B. Samples of each type of raceway and accessory.

1.5. SHOP AND CONSTRUCTION DRAWINGS: submit drawings for approval including, but not limited to, the followings:

A. Exact routing of conduits, trunking etc. With indication of boxes, accessories and expansion joints, size of conduits and boxes

B. Typical assembly details of installation of trunking, trays etc.

C. Construction details of pull boxes.

D. Typical installation details including connection of conduits to metal enclosure. Connections of flexible conduits, vapour- tight installations in cold rooms, liquid tight flexible metallic outdoors etc. and earthing connections.

1.6. APPROVED MANUFACTURERS: obtain conduit, wireways and related accessories from one of the following or other equal and approved:

A. UNIVOLT (Austria)

B. EGA Tubes (England)

C. DIELECTRIX (England)

D. Siemens (Germany)

E. Simplex (England)

F. Decoduct (UAE)

2. PRODUCTS AND SYSTEMS

2.1. CONDUITS AND ACCESSORIES

2.1.1. RIGID & FLEXIBLE METAL CONDUIT

A. MATERIAL: steel, cold rolled and annealed, non-threaded type, formed from continuous length of helically wound and interlocked strip steel, with fused zinc coating on inside and outside. Black enameled or hot dipped galvanized, L= 3m, screwed on both ends to NF-C-68-100. Locally manufactured conduits shall not be accepted.

B. LIQUID- TIGHT FLEXIBLE METALLIC CONDUIT: is to have PVC jacket extruded over core.

C. FITTINGS GENERALLY: thread less, hinged clamp type, hot dipped galvanized or cadmium plated malleable cast iron. Fittings used in corrosive atmospheres are to be specially treated.

D. STRAIGHT CONNECTORS: one piece body, female type, hot dipped galvanized or cadmium plated malleable cast iron. Fittings used in corrosive atmospheres are to be specially treated.

E. ANGLE CONNECTORS: of 45 or 90 degree and terminal connectors are to be as specified for straight connectors, except that body is to be two-piece with removable upper section.

2.1.2. RIGID MEDIUM GAUGE PVC CONDUIT.

A. MATERIAL: rigid un-plasticized, could form a bend with PVC accessories, polyvinyl chloride with high impact and high temperature resistance, flame retardant, non hygroscopic and non-porous, compressive strength $\geq$ 750 N, to CEE 26, BS 4607 and BS 6099, DIN 49026, NFC 68-107 or other equal and approved standards conforming to IEC 423.

B. FITTINGS GENERALLY: unbreakable, non-inflammable, self-extinguishing, moulded plastic.

C. ASSEMBLY: conduits, boxes and accessories are to be assembled by cementing, using manufacturer's recommended products and appropriate connectors or spouts are available use smooth bore male PVC bushes and sockets.

2.1.3. FLEXIBLE MEDIUM GAUGE PVC CONDUIT

A. MATERIAL: flame retardant, heat resistant, non-hygroscopic PVC, high resistance to impact, ribbed on circumference for flexibility.

3. FIELD AND INSTALLATION WORK

3.1. CONDUIT AND WIREWAYS GENERALLY

A. USE: unless otherwise specifically indicated all light and power circuits, communications, signal and low current systems wiring are to be drawn inside conduits or wireways up to the various electric power consuming equipment as shown on the Drawings. Separate conduit and wireways installations are to be used for LV cables/wires normal light and power circuits, emergency light and power circuits and communication, signal and other low current systems wiring.

B. BOXES: junction, pull and splice boxes of ample capacity are to be provided as indicated or required. Boxes are to remain permanently accessible.

C. TOOLS AND ACCESSORIES: for forming and installing conduit and wireway systems are to be purpose made for the particular application and used in accordance with manufacturer's instructions.

D. FIXING: conduits and wireway installations are to be concealed as much as possible.

E. SIZES: Unless otherwise specified conduits and wireways sizes, not shown on the Drawings, are to be selected in accordance with the tables on design drawings and in relation to the number and size of conductors. Minimum size of conduit for all applications is to be 20 mm diameter, unless otherwise shown on the Drawings.

F. MECHANICAL CONTINUITY: conduits and wireways are to be effectively joined together and connected to electrical boxes, fittings and cabinets to provide firm mechanical assembly. Earthing jumpers are to be installed on steel conduits where required to ensure effective electrical continuity irrespective of whether a protective earth conductor is required or not.

3.2. PVC CONDUITS

A. COUPLING OF CONDUIT and/ or termination into spouted fittings are to be made watertight and permanent using special cement.

B. TERMINATION: connect conduits terminating in switchgear, fuse boards, trunking, adaptable boxes or non-spouted enclosures etc, with smooth bore male PVC bushes and sockets.

C. ENDS OF CONDUIT end conduit fittings are to be cleaned and jointed using PVC cement recommended by manufacturer.

D. SEMI-PERMANENT ADHESIVE: use in joints requiring expansion couplers.

3.3. EMBEDDED CONDUITS

CONDUITS IN CONCRETE SLABS: place conduits parallel to main reinforcing steel.

B. CONDUITS IN PARTITIONS OR SIDE WALLS: horizontal or cross runs are to be avoided.

C. PULL-BOXES are not to be used. If unavoidable, pull-boxes may be approved if located inconspicuously.

D. CONDUITS IN FLOOR OF BEDS ON GRADE: encase in concrete, minimum thickness 50 mm or to thickness allowed by architectural detail.

E. PVC CONDUITS IN REINFORCED CONCRETE STRUCTURES are generally to be installed after placing reinforcement and before concreting, if protected against damage, or are to be placed in grooves in formed in the concrete, if approved.

3.4. EXPOSED CONDUITS

A. CONDUITS ON WALLS: run neatly, horizontally or vertically.

B. SUPPORTS: use approved clamps, hangers or clips fastened by machine screws to expansion sleeves in inserts or to lead anchors.

C. SPACING OF CLAMPS OR CLIPS for supporting steel conduits is not to be greater than:

Conduit Size mm (inches)	Maximum Spacing of Supports meters
20 (3/4)	1.5 m
25 (1)	1.5 m
32-38 (1-1/4-1-1/2)	2 m

D. SPACING OF CLAMPS OR CLIPS for supporting PVC conduits is not to be greater than.

Conduit Size mm (inches)	Maximum Spacing of Supports meters
20 (3/4)	0.60
25-50 (1-2)	0.75
63-75 (2-1/2-3)	0.90

E. BENDS AND FITTINGS: firmly fasten conduit at each side of bends and within 900 mm of each outlet box, junction box, cabinet or fitting.

F. OUTLETS: do not run more than one conduit to any surface wall outlet. Install junction box on home run near to ceiling level and tap-off vertical conduit to outlet box below.

4. WIRES & CABLES

4.1 GENERAL

The section shall cover all wires and cables.
The Contractor shall supply and install all wires and cables necessary for the complete Electrical System, as indicated on the Drawings, as required, and as specified herein.

4.2 WIRES & CABLES - LIGHTING & POWER

A. Single Core Wires (NYA) Cu/PVC to IEC 227

1. This specification covers single core, PVC insulated wires, intended for internal wiring in dry locations, concealed in conduits.

2. Conductors shall be of high conductivity annealed plain copper with concentric stranded conductors, to IEC 228.

3. Minimum conductor size used shall not be less than 2.5 mm^2.

4. All wires for lighting and power systems pulled inside conduits shall be single core, insulated with PVC compound, of grade not less than 300 / 500 volts, to IEC 227.

B. Multicore Cables (NYY) Cu/ PVC/ PVC to IEC 502

NYY cables shall be used for supply of power to main distribution boards, secondary distribution boards, pumps, HVAC equipment and all external lighting and equipment.

This specification covers single, two, three or four core cables, PVC insulated and PVC sheathed, rated at 600V/1000 V unarmored and armored type.

Conductor shall be plain, annealed electrolytic copper, circular or sectoral stranded, conforming to the applicable requirements of IEC 228.

The insulation shall be PVC based thermoplastic material conforming to the applicable requirements of IEC 502.

The assembly shall consist of insulated conductors filled where necessary with non-hygroscopic material and covered with an additional layer of extruded thermoplastic material or non-hygroscopic binding tape.

The sheath shall be PVC based thermoplastic material, conforming to the applicable requirements of IEC 502.

Flexible cords for connection of fixtures to circuit-wiring shall have finely stranded copper Conductor with a PVC insulation, type NYFAF, 500 V grade. Connection caps shall be "3M" instead of WAGO in this case only.

Wires and cables shall be manufactured by BICC (UK), Pirelli (UK), Liban Cables (Lebanon) or approved equal.

4.3 FLEXIBLE CORDS

Cords used for water heater connections shall be of high conductivity tinned copper wires, (2.5 mm^2 unless otherwise indicated) insulated with ethylene propylene rubber, three cores twisted together, filled and sheathed with chlorosulphonated polyethylene (EPR CSP), 300/500 V rated, and shall withstand an operating temperature of 85 °C.

Cords used for pendant lighting points and between 220 V / 12 V transformers to lighting fixtures, shall be circular three core (1.5 mm^2) silicon rubber insulated, glass fiber braided 300/500 V rated and shall withstand an operating temperature of 150 °C.

Cords used for extract fans and fan coil units shall be of plain annealed copper conductor (2.5 mm^2 unless otherwise indicated), PVC insulated, circular three cores twisted together, PVC overall sheeted 300 / 500 V rated and shall withstand an operating temperature of 70 °C.

Cords shall be manufactured by BICC (England), AEI (England) Pirelli (England), Liban Cables (Lebanon) or approved equal.

4.4 CONTROL CABLES

Control cables where used underground direct burial shall comprise stranded annealed copper conductor of minimum 2 mm^2 cross-section insulated with high dielectric polyvinyl chloride, nylon sheathed with a tape binder applied over the assembly, overall PVC jacketed Control cables shall comply with IEC 502.

Number of conductors shall be equal to the maximum number of functions plus 20% spare.

Cable shall be 600 /1000V insulated and sheathed grade.

Junction boxes shall include all necessary terminal connector boards with proper labels.

Contractor shall make sure that the cross-sectional area of the conductors are sufficient to cater for the voltage drop due to the long runs involved.

Control cables where used in ducts underground or in conduits above ground shall comprise stranded annealed copper conductor of minimum 2 mm^2 cross-section for cables in ducts and 0.75 mm^2 for cables in conduits insulated with high dielectric polyvinyl chloride, and PVC sheathed. Control cables shall comply with IEC 502.

4.5 INSTALLATION OF WIRES & CABLES

All wires shall be installed in accordance with the applicable provisions of the approved codes and as indicated on the Drawings.

The number of wires and sizes of conduits indicated on the Drawings are a guide only and are not necessarily the correct number and sizes necessary for actual equipment installed. The Contractor shall install as many wires and conduits as required and necessary for a complete electrical system, and shall provide adequately for the equipment actually to be installed.

Where more than one conductor is used per phase, each phase, neutral if any and ground wires shall be run in each metallic or non-metallic conduit.

Conductors shall be continuous from outlet to outlet and no splices shall be made except within outlet or junction boxes.

At every outlet and pull box, wires and cables passing through, shall be left slack by an amount equivalent to 20 cm of cable length to allow inspection and connection to be made therein.

No cable bend shall have a radius of less than eight times its diameter.

The Contractor shall not change any circuit number, especially from a phase to a different phase. If such a change is necessary due to modification on site, the Contractor shall bring this matter to the attention of the engineer.

All conductors to be contained within a single conduit shall be drawn in at the same time.

A wire pulling compound shall be applied to conductors being drawn through conduit. Pulling compound shall be soap

tone or other approved material.

Only cables forming part of a lift installation if any may be run in a lift shaft.

Wires and cables for feeders, sub-feeders, control, and branch circuit wiring shall be color coded as follows:

Color	Conductor Function	Alternative Color
Brown	L 1	Red
Black	L 2	Blue
Orange	L 3	Yellow
Light Blue	Neutral (N)	Black
Green/Yellow	Equipment grounding (PE)	Green/Yellow

Wire and cable sizes shall be as indicated on the Drawings; however in no case shall their size be smaller than required by the approved Code.

Unless otherwise indicated, no conductor for lighting and power wires shall be smaller than 2.5 mm^2.

All branch circuits for internal lighting and appliances shall be single conductor cables run inside conduits, unless otherwise indicated.

Feeder and sub-feeders shall be multi-conductor cables run exposed on cable trays or in underground ducts as shown on the Drawings.

Single cables unless otherwise specified and shown on drawings, could be fixed directly to walls or ceilings. Where 2 or more cables are run in parallel, they shall be fixed on hot dip galvanized steel perforated trays or other approved special cable supporting and protecting arrangement.

Cables shall be fixed to supporting structures with approved hot dip galvanized cast steel clamps at distances not exceeding 20 diameters.

No joints or splices shall be accepted on main feeders.

4.6 IDENTIFICATION OF WIRES & CABLES

Individual conductor or circuit identification shall be carried throughout, with circuit numbers or other identification clearly installed on terminal boards and printed on directory cards in distribution cabinets and panelboards. System shall be similar to Legrand CAB3 or approved equal.

In junction boxes, cabinets, and terminal boxes where the total number of control, indicating, and metering wires is three or fewer and no terminal board is provided, each wire including all power wires, shall be properly identified by means of a plastic, wire marker.

System shall be similar to Legrand Mémocab or approved equal.

Wires including motor leads and other power wires too large for connection to the terminal boards shall be identified by wire markers as specified above.

In manholes, hand-holes, pull boxes, junction boxes and at both terminals each cable shall be properly identified by a plastic tag located so as to be easily seen. System shall be similar to Legrand Duplix or approved equal. Wires and cables shall be identified by cable number indicated on the Drawings.

4.7 CONNECTORS AND TERMINAL BLOCKS

For the wiring of circuits consisting of wire sizes 6 mm^2 and smaller such as for lighting, branch circuits etc…, WAGO, self insulated pressure type connectors shall be utilized for all splices or joints. Where flexible cables (NYFAF) are used from ceiling outlet box to recessed lighting fixtures, 3M caps shall be utilized.

For the wiring of circuits consisting of wire sizes 10 mm^2 and larger, connectors shall be of the bolted pressure type, with a pre-insulated sleeve. WAGO or Legrand Viking shall be used Connectors shall be manufactured from high

conductivity copper, electro tin-plated.

Connector bodies shall be manufactured from Polyamide.

4.8 CABLE TRAYS AND SUPPORTS

Cable trays shall be manufactured from mild steel of a minimum thickness of 2 mm. They shall be light or heavy duty type as required with return flanges, and hot-dip galvanized finish. Bends, corners, etc.. shall be specially manufactured for the purpose.

All supports and accessories like hangers, channels, bolts, nuts, cable ties, conduit clamps, shall be furnished as to function, to the manufacturers standard. Metallic elements shall be hot dip galvanized.

The contractor shall provide technical catalogues and shop drawings to illustrate the sufficiency of the supports and tray sections thickness.

The installation shall have a design assuming double at the actual load in addition to the safety factor recommended by the tray manufacturer.

Cable trays, supports, and accessories shall be manufactured by BICC (England) or approved equal.

4.9 CABLE LADDERS

Cable ladders shall be manufactured from mild steel, with hot-dip galvanized finish.

All parts like flat elbows, offset reducers, cross pieces, tee pieces, drop outs, etc..., as well as accessories shall be furnished as to function, and to the manufacturers standards.

The contractor shall provide technical catalogues and shop drawings to illustrate the sufficiency of the supports and tray sections thickness.

Cable ladders, parts and accessories shall be manufactured by BICC (England), Planet-Walthom or approved equal.

4.10 CABLE GLANDS

Cable glands shall be provided at the termination of all cables at the enclosure of a distribution board or any other equipment.

Cable glands shall be indoor or outdoor type, ordinary or weatherproof according to the location of the termination, the installation standard and to the approval of the Engineer.

CHAPTER 4
WIRING DEVICES AND DISCONNECTS

1. GENERAL

1.1. GENERAL WORK GENERALLY is to be in accordance with the requirements of the chapter 1 of the Specification.

1.2. DESCRIPTION OF WORK: wiring devices, lighting switches, socket outlets, cord outlets, automatic and manual lighting control equipment, dimmers, outlet boxes and plates, disconnect switches etc.

1.3. STANDARDS: components are to be standard manufactured items, uniform and modular, complying with one set of approved Standards.

1.4. EQUIPMENT DATA: submit data for approval, including catalogues, detailed literature, manufacturer's name, catalogue number, rating, specification, overall dimensions and special features, as applicable for each item.

1.5. SHOP AND CONSTRUCTION DRAWINGS: submit drawings for approval including, but not limited to, the following:

A. Exact indication of position of each item and outlet box and fitting on layout drawings, with box and equipment types and sizes.

1.6. SAMPLES: submit samples of each type of device for approval, unless otherwise agreed in writing by the Engineer.

2. PRODUCT AND SYSTEMS

2.1. FITTINGS

2.1.1. OUTLET BOXES AND PLATES GENERALLY

A. SURFACE OR RECESSED BOXES are to be suitable for type of related conduit or cable system. Shapes and sizes of boxes are to be compatible standards as switches, socket outlets and lighting fixtures selected and of various types and mounting methods required.

B. UNUSED OPENINGS in outlet boxes are to be closed with knock-out closers manufactured for the purpose.

C. BLANK PLATES: blank plates are to be installed on outlet boxes on which no apparatus is installed or where apparatus installed does not have suitable cover for box. Blanks plates for wall outlets are to be attached by a bridge with slots for horizontal and vertical adjustment.

2.1.2. MOULDED PLASTIC OUTLET BOXES

A. TYPE: boxes and covers used with PVC conduit systems are to be heavy gauge pressure moulded plastic, minimum 2 mm thick, self extinguishing, with softening point not less than 85 deg. C. Boxes are to have provision for securely terminating conduits and are to be

manufacturer's standard for required application.

B. FITTINGS: boxes are to have brass inset threads to receive cover screws and for mounting devices or accessories, push- fit brass earth terminals, and steel insert clips to provide additional support for pendants or for heat conduction. Neoprene gaskets are to be provided for weatherproof installations.

C. MANUFACTURERS: obtain moulded plastic outlet boxes from:
1. Egatube (England)
2. M.K. (England)
3. Legrand (France)
4. B Tichino (Italy)

Or other equal and approved.

2.1.3. SWITCHES

A. GENERALLY: quick- make, quick- break type with silver alloy contacts in arc resisting moulded base, with toggle, rocker or push- button as specified, for inductive or resistive loads up to full rated capacity, and arranged for side and/or back connection.

B. TYPES: single, two- way or intermediate, single pole or double pole, as shown on the Drawings.

C. GENERAL LIGHTING SWITCH: 10 A 220 V a.c., rocker operated, grid- switch with plastic plate, for indoor installations in general, unless otherwise indicated.
1. Man: Legrand or other equal and approved.

Ref: unless otherwise mentioned on drawings:
One way one gang 74010
One way greater or equal to two gang 74000

D. PUSH BUTTON SWITCH, Ref unless otherwise mentioned on drawings:
One gang 74040
Two or larger than 74030.

E. MANUAL SWITCH: 2 pole, for fractional single and three phase motors and appliances, to interrupt motor and induction loads, rated 20 A at 415 V a.c., toggle operated, with positive indication of on/off position of contacts.
1. Man: Merlin Gerin or other equal and approved.
2. Ref: [(15006 + 13392) when installed as one gang] for single phase, (15007 + 13392) for three phase (without Neutral) and (15008 + 13392) for three phase (with Neutral).

2.1.4. SOCKET OUTLETS

A. GENERALLY: to have injection molded plastic base with self- adjusting, non-expanding contacts to prevent permanent distortion, arranged for side and/or back connection and with screw terminals accepting at least three parallel branch- circuit wires.

B. TYPES: general-purpose socket outlets are to conform with standard German practice concerning layout & rating).

C. DUPLEX SOCKETS are to be mounted in parallel under one common plate with break- off feature for two-circuit connection

D. WEATHERPROOF SOCKET OUTLETS are to be any of the types indicated, enclosed in surface mounted cast metal box and with cover comprising spring- retained gasketted hinged flap. Enclosure is to be pre- designed box and cover for type of socket outlet specified.

E. GERMAN STANDARD SOCKET: single phase, three wire for plug with 3 mm round pins at 19 mm centers, with grounding in accordance with standard German practice and rated 10/16 A, 250 V a.c.
1. Man: Legrand or other equal and approved.

2. Ref: 74130 (and 74132 for UPS).

2.1.5. PLUGS

A. TYPE: compatible with type of socket outlet specified, break resistant, of impact resistant moulded insulating material (separable construction), with solid brass pins and cord grip and of shape providing easy hand- grip for removal.

B. QUANTITY: supply number equal to 20% of total number of each type of socket outlet supplied.

2.1.6. SWITCH DISCONNECTOR (DISCONNECTING SWITCH)

A. RATING: 690 V, 2,3 or 4 pole, load break, short- circuit make, in accordance with IEC 947-3, utilization category 22 for heating and lighting loads, category 23 for motor circuits, and with ampere rating shown on the Drawings.

B. DESIGN: non- fusible, air- break switch disconnect, single throw, safety type, housed in separate metallic enclosure with arc quenching devices on each pole.

C. OPERATING MECHANISM: quick- make, quick- break, independent of operator, with external operating handle mechanically interlocked to prevent opening door unless switch is in open position. Switch disconnect is to have provision for by- passing interlock. Position of handle is to be positive and clearly indicated on cover.

D. ENCLOSURE: General purpose sheet steel for indoor use IP 42 and weather- proof type cast-metal or sheet steel for outdoor installations IP 65 IK 08, unless otherwise required or shown on the Drawings. Locking of operating handle is to be possible in open and closed positions.

E. MANUFACTURERS: obtain switch disconnect from one of the following of the following or other equal and approved:

1. Merlin Gerin (France)
2. Klockner Moeller (Germany)
3. ABB (Germany)
4. Siemens (Germany)
5. Socomec (France)
6. Legrand (France)

3. FIELD AND INSTALLATION WORK

3.1. INSTALLATION

A. LOCATIONS: the Drawings generally show approximate locations of outlets and equipment. Exact locations are to be determined from interior finishing and detail drawings. Any condition that would place an outlet in an unsuitable location is to be referred to the Engineer. Locate switches at strike sides of doors, whether shown on the Drawings or not. In locating outlets allow for overhead pipes, ducts, variations in arrangement, thickness of finishing, window trim, paneling and other architectural features.

B. MOUNTING HEIGHTS for outlet boxes and similar equipment are to be uniform within the same or similar areas. Mounting is to be as shown on the Drawings or as approved by the Engineer. Unless otherwise shown or instructed, mount lighting switches and socket outlets

generally at 1200 mm and 300 mm from finished floor level respectively. Mount switches with long dimension vertical and operating handle, if of the toggle type, up when in the on position.

C. SINGLE POLE SWITCHES are to switch the phase wire. Do not run neutral wire through switches having neutral shunt or bridge.

D. ADDITIONAL OUTLETS to those shown on the Drawings are to be provided as required by equipment manufacturers for control or other wiring.

E. EXPOSED OUTLET BOXES: securely fasten to wall with machine screws to permanent inserts or lead anchors.

F. RECESSED OUTLET BOXES: make neat openings, to the satisfaction of the Engineer, allowing for thickness of finishing and use extension rings if required. Repair damaged finishing to original condition before installation of fittings or plates.

G. APPEARANCE: install exposed boxes and plates plumb, square and parallel to finished wall surface. Exposed plates covering recessed boxes are to rest neatly on wall surface without gaps, and fully covering the box.

H. GROUPED OUTLETS: arrange neatly so that use of fittings is convenient and clear.

I. WATERPROOF AND EXPLOSION- PROOF FITTINGS: follow manufacturer's instructions for installation and connection to conduit system to fully achieve required degree of protection.

J. DAMAGED FITTINGS: reject damaged fittings or plates with damaged finish. Protect fittings and plates against damage after installation and handed over.

K. CONNECTION OF APPLIANCE:
1. Where appliance is designed to adapt directly to outlet box, extend electrical wiring to incoming terminals inside appliance.
2. Where appliance is not designed to adapt to outlet box, install connecting wiring in flexible conduit firmly fixed to outlet box cover plate and to terminal box on appliance.

3.2. INSPECTION AND TEST ON SITE

A. VISUAL INSPECTION: fittings and equipment are to be inspected for fixing and workmanship.

B. MEGGER TESTS are to include switch and socket outlet tests together with insulation resistance of wiring installations.

C. OPERATION: devices are to be tested for operation and are to perform as intended at full load without any signs of heating.

D. EQUIPMENT is to be insulation tested and observed, under full- load for not less than 3 days operation, with respect to undue heating and performance in general.

CHAPTER 5
GENERAL LIGHTING INSTALLATION

1. GENERAL

1.1. ELECTRICAL WORK GENERALLY is to be in accordance with the requirements of the chapter 1 of the Specification.

1.2. DESCRIPTION OF WORK: complete indoor and outdoor lighting installations including fixtures, control gear, mounting provisions, accessories and connection to circuit wiring and to corresponding lighting control equipment.

1.3. FIXTURE DESIGN AND STANDARDS: the Specification and the Drawings are a guide to the selection of lighting characteristics and lighting fixtures, giving general features of construction, materials, method of installation and conditions of operation. Unless otherwise specified, fixtures are to be manufacturer's standard series, designed and manufactured for the purpose and application required, generally in accordance with the Schedule of Lighting Fixtures and complying with IEC 598 and CISPR 15.

1.4. DESIGN LAYOUT: fixture layout has been determined from photometric data of specified fixtures to achieve desired level and uniformity of illumination. Reflected ceiling plans are to be checked to ensure exact positions of fixtures with respect to structural members, ducts pipes, other installations and ceiling panels/tiles, where required.

1.5. EQUIPMENT DATA: submit data for approval including, but not limited to, the followings:

A. Detailed literature on each fixture, lamp and control gear including manufacturer's name, catalogue number, rating, material specification, overall dimensions, operating characteristics and principals.

B. Details of changes to standard fixtures for adaptation to condition of installation and to the Specification.

C. Photometric data for lighting calculations including polar light distribution curves, coefficient of utilization, glare classification, efficiency, depreciation factors etc.

1.6. SAMPLES: submit fully equipped sample of each fixture type, modified if required, together with color and texture samples of each fixture.

2. PRODUCTS AND SYSTEMS

2.1. COMPONENTS AND ACCESSORIES

2.1.1. LIGHTING FIXTURE CONSTRUCTION-GENERAL

A. GENERALLY: construction and wiring of fixtures are to comply with the Regulations and Standards. Fixtures are to be fabricated, assembled and wired entirely at factory. Manufacturer's name, factory inspection stamp and official quality label are to be fixed to each fixture supplied.

B. LIGHTING FIXTURES (LUMINAIRES): to be manufacturer's standard, as given in Lighting Fixture Schedules shown on the Drawings, or equal.

C. SHEET STEEL HOUSINGS: to be not less than 0.6 mm thick, and thicker when required by the Specification or the Standards.

D. SHEET STEEL REFLECTORS: to be not less than 0.5 mm thick.

E. ALUMINUM REFLECTORS: to be not less than 0.7 mm thick, unless otherwise approved.

F. FABRICATION: metalwork is to be mitred, welded and ground smooth without tool marks or burrs. Flat metal parts are to be stiffened by forming grooves and edges during fabrication. Metal parts are to have finish free from irregularities.

G. RUST-PROOF FERROUS BASE: ferrous metal parts are to be bonderized (treated with corrosion resistant phosphate solution) and given an approved rust-inhibiting prime coat before application of final finish.

H. FINISH FOR NON-REFLECTING METAL SURFACES: approved baked enamel paint. Paint color on fixture frames and trims is to be as specified or as selected by the Engineer.

I. FINISH FOR LIGHT REFLECTING SURFACES: white baked enamel paint having reflection factor not less than 85%. Mirror reflectors, where specified, are to be highly polished, anodized aluminum with reflection factors not less than 97%.

2.1.2. FLUORESCENT FIXTURES

A. LAMP HOLDERS GENERALLY: to IEC 400, heavy duty, moulded white plastic with non-corroding spring contacts.

B. LAMP HOLDERS FOR INDUSTRIAL FITTINGS: spring loaded turret type, heavy duty, dust protected.

C. BALLASTS GENERALLY: to IEC 82. Only single (36 W) or two-lamp (18 W) ballasts are to be used in any one fixture. Two-lamp ballasts are to be lead-lag, series type. Equipment is to be enclosed in sheet steel casing with corrosion resistant finish.

D. BALLAST THERMOSETTING COMPOUND is not to soften, liquify or support combustion under any operating condition or upon ballast failure, and is to fill ballast enclosure and dampen vibrations. Temperature rise, under normal operating conditions, is not to exceed 55 deg. C above maximum ambient temperature of 40 deg. C.

E. BALLAST PROTECTION: each ballast is to have one-time external fuse and fuse holder rated in accordance with manufacturer's instructions.

F. BALLAST TYPE: electronic or electronic high frequency dimmable type, as stated in fixture description and as shown on the drawings, power factor corrected to above 0.9, having manufacturer's lowest case temperature. Sound rating is not to exceed level given in the Standards. Harmonics to IEC EN 60929, radio interference suppression to IEC EN 55015 and immunity to IEC EN 61547. The ballast shall operate at a frequency not less than 30kHz.

G. BALLAST RATING: ballast is to be manufactured and certified for the specific lamp it controls and for operation from nominal power supply, with voltage and frequency equal to nominal voltage and frequency of distribution network.

H. CAPACITORS: to IEC 566, having snap-type connectors and fastening, bolt type M8, for fixing to fixture.

I. STARTERS, if required, are to comply with IEC 155, and are to be selected in conjunction with respective ballast and lamp.

3. FIELD AND INSTALLATION WORK

3.1. INSTALLATION

A. GENERALLY: install fixture level, aligned and parallel or square to building lines and at

uniform heights as shown on the Drawings or as approved by the Engineer. Make final height adjustment after installations.

B. FIXTURE SUPPORT: provide fixture and/or fixture outlet boxes with hangers, brackets and flanged bolted fittings, as necessary, to support weight of fixture. Submit details of hangers etc. and method of fastening for approval. Rigidly secure fixture mounted on outlet boxes to fixture studs. Install hooks or extension pieces, when required, for proper installation. Provide one point of support in addition to the outlet box fixture stud for individually mounted fixtures longer than 600 mm.

C. SUSPENDED CEILINGS: if ceiling construction is unable to support weight of fixtures without strain or deformation, suspend fixtures directly from building structure.

D. SOLD CEILINGS: coordinate dimensions of recesses in ceilings with exact fixture dimensions and structural elements.

E. CONTINUOUS ROWS: arrange fixture so that individual fixtures can be removed without dismantling remaining fixtures. Provide minimum spacing between fixtures.

F. COVER PLATES: install cover plates over fixture outlet box or opening in ceiling or structure when left unused.

G. FLUSH RECESSED FIXTURES: install to completely eliminate light leakage within fixture and between fixture and adjacent finished surface.

H. VENTILATION: keep ventilation channels free after fixture is installed, if required by the design of the fixture.

I. EARTH metal frames of fixtures as described in Section 219 of the Specification.

J. TIGHTNESS: ensure that enclosed fixtures are reasonably insect/ dust tight when installed, and completely weather-proof for installations subject to weather conditions.

K. LAMPS FOR PERMANENT INSTALLATION: place new lamps in fixtures immediately prior to hand-over and when instructed by the Engineer. Lamps used for temporary service are not to be used for final lamping of fixtures.

3.2. **INSPECTION AND TESTS ON SITE**

A. VISUAL INSPECTION: check neatness of installation, uniformity of equipment and nameplates etc.

B. ILLUMINATION MEASUREMENTS: to be taken at selected locations, to determine level and uniformity.

C. OPERATION: check lighting installations for operation including control and regulation equipment.

D. ELECTRICAL DATA: measure power factor, current and voltage at start for installations with discharge lamps.

CHAPTER 6
TELEPHONE INSTALLATIONS WITH E-PABX SYSTEM

1. GENERAL

1.1 **ELECTRICAL WORK GENERALLY** is to be in accordance with the requirements of the chapter 1 of the Specification.

1.2 DESCRIPTION OF WORK: **complete telephone distribution network including private telephone exchange system (EPABX) including, but not limited to, the followings:**

A. Main Telephone Terminal Frame (MDFs)

B. Secondary telephone distribution boxes.

C. Telephone cables.

D. Telephone outlets (as part of the structured wiring system).

1.3 REGULATIONS AND STANDARDS: **telephone installations are to comply with the requirements of PTT and the relevant CCITT recommendations and the Electronic Industries Association / Telecommunication Industry Association Standard EIA/TIA- 568 "Commercial Building Telecommunication Wiring Standard" or ISO/IEC-11801 "Information Technology – Generic cabling for customer premises" as for the material installed.**

1.4 EQUIPMENT DATA: **submit data for approval including complete technical data and manufacturer's catalogues for all equipment and materials.**

1.5 SHOP AND CONSTRUCTION DRAWINGS: **submit drawings for approval including, but not limited to, the following:**

A. Detailed system schematic diagram

B. Detailed layout of all equipment in rooms, including elevations

C. Exact routing and layout of all cabling and wireways

D. Typical installation details of cabinet (s), boxes, and other equipment.

2. PRODUCTS AND SYSTEMS

2.1 TELEPHONE DISTRIBUTION COMPONENTS

A. MAIN DISTRIBUTION FRAME (MDF) is to be of size suitable for ultimate capacity of telephone network. All internal lines individual telephone distribution boxes are to be connected to MDF. Terminals are to be identified by reusable numbered tags corresponding to respective lines and extensions. Proposed numbering scheme is to be submitted for approval. Lines are to be connected by quick clip Insulation Displacement contact (IDC). Soldering will not be allowed. Patching inside MDF between telephone operator section and telephone backbone section shall be using factor tested patch cords IDC-IDC.

B. SECONDARY TELEPHONE DISTRIBUTION BOXES: steel or metal alloy, general purpose enclosures, for surface or concealed mounting, of size and at location shown on the Drawings, dust- proof, IP 42 protection for indoor mounting to IEC 529, with tamper- proof screwed covers.

C. TERMINAL BLOCKS: plug- in quick connect type rated to EIA/TIA 568 or IEC 11801 Category 5, for 100 Mbps transmission speed. Blocks are to be of the insulation displacement connector (IDC) method. Conductors are not stripped, but forced into a terminal strip containing sharp inside edges that pierce the insulation and make solid connection. The wire is to be held tightly between the metal contacts, forming a gas tight seal. All connections are to be made using a special punch down tool. Provide a spare tool to the user for future wiring additions and alterations. Patching between blocks to be via twisted pairs (jarretieres).

D. CONDUITS AND RACEWAYS are to be provided in accordance with Sections 16118 of the Specification.

E. TELEPHONE SYSTEM CABLES are to be 100 ohm unshielded twisted pair (UTP) to EIA/ TIA- 568 or IEC 11801 category 5 wiring standard. Cables are to be four- pair to telephone outlets (RJ45 CAT5) and multi- pair CAT5 composite media cables for backbone distribution. Indoor cabling is to be polyethylene insulated, tinned solid copper conductors, twisted into pairs, color coded and gray PVC sheath. Minimum diameter of conductor is to be 0.6 mm.

F. MULTI-PAIR CABLES for installation in duct banks, outdoors are to be non- hygroscopic, waterproof, polyethylene insulated, tinned solid copper conductors, minimum 0.6 mm diameter, twisted into pairs, color coded, with wrapping of aluminized polyester tape, PVC tape, aluminum or copper sheath and PVC over- sheath.

G. CABLE RATING: cables are to be rated for maximum operating voltage of 150 V, with insulation resistance of 10,000 megaohm/km, and tested at 500 V d.c. applied core- core and core- earth.

H. TELEPHONE OUTLETS (refer to section 16740) are to have modular grid box and cover plates similar to other socket outlets and switches described in the Specification. Jacks are to be modular unshielded 8 positions RJ 45 CAT.5 compatible with RJ11 & RJ12 plugs.

3. FIELD AND INSTALLATION WORK

3.1 INSTALLATION

A. EQUIPMENT INSTALLATION ON SITE is to be limited to fixation and inter- wiring of various items of the ready made equipment.

B. CABLES are to be run on cable trays, in conduits above suspended ceilings, in walls or under floors in a manner to protect them from physical damage and excessive heat, and to permit ease of accessibility for servicing and modifications. Fixing accessories are to include two- piece plastic clamps, galvanized screws, wall base- holders and fibber- plastic inserts or raw- bolts, subject to the approval of the Engineer.

C. CONDUITS: in accordance with the Specification.

D. EARTHING: provide interference- free earthing as necessary.

E. TOOLS: use only proper tools for all installations work particularly in making connections.

F. SUPERINTENDANCE: carry out installations under the direct supervision of a qualified technician, licensed by and trained at the factory.

3.2 MISCELLANEOUS ITEMS

A. SPARE PARTS AND TOOL KITS are to be provided as per the manufacturer’s recommendations for electronic boards, IDC connection modules, telephone outlets, board extractors, cleaning kits, test stations, digital multimeter and battery testing kit.

3.3 MEASUREMENT

A. **Main Distribution Frame (MDF);** shall contain but not limited to all items listed below:

1. Connections (patching) between primary and secondary part of the MDF using twisted pairs (jarretières) length as necessary through horizontal & vertical cable management.

2. All necessary accessories for ventilation, fixing, complete labeling of all modules and cables, cable and cord horizontal and vertical management for whole MDF.

3. 8 pair disconnection module CAT5 with quad channeled wire guides above and by pairs below (4 modules for each 25 pairs cable, 3 modules for each 3x4 pairs cable and 13 modules for each 100 pairs cable):

1) Primary Part:

a) 42 disconnection modules (4 modules spare) for 3 incoming 100 pairs cables from PSTN.
b) Three-pole surge protection module. Line continuity with 3-pole voltage surge arrestor, two PTC (positive temperature coefficient) current surge protections, lines are earthed after fail-safe voltage surge arrestor has tripped. Surge protections are mounted on the 42 modules above.

2) Secondary Part:

a) 42 disconnecting modules (4 modules spare) for cables up to consumer voice access points and general services PABX.

4. Distribution frame 2x65 pitches with 2 wall attachments brackets fitted with 2 rails 250mm apart, channel shaped aluminum rails with a depth of 90mm with module attachment every 16mm, extruded aluminum trunking with cover and open rings for jump ring cords.
5. Cover for distribution frame made from Lacquered steel with lockable full door.

B. **Telephone (voice) network consumer access point type "T1"** shall consist of a shock resistant polystyrene enclosure with a twist-lock lid, profile for fixing IDC CAT5 modules, 1x10 way PCB earth strip and 1x8 pairs CAT5 IDC modules.

C. **Telephone (voice) network consumer access point type "T2"** shall consist of a shock resistant polystyrene enclosure with a twist-lock lid, profile for fixing IDC CAT5 modules, 1x10 way PCB earth strip and 3x8 pairs CAT5 IDC modules.

CHAPTER 7
DATA SYSTEM

Part 1 - GENERAL

1.01 PURPOSE

A. The Purpose of this document is to describe in detail the passive system design and to define the minimum required specification for system component in term of performance and characteristics.

1.02 APPLICABLE DOCUMENTS

A. The cabling system described in this specification is derived in part from the recommendations made in industry standard documents. The list of documents below is incorporated by reference:
   1. This Technical Specification and Associated Drawings
   2. © 2009 BICSI® Telecommunications Distributions Methods Manual, latest edition.
   3. ANSI/TIA/EIA-568-B.1 Commercial Building Telecommunications Cabling Standard 2001.
   4. Commercial Building Telecommunication Cabling Standards (ANSI/TIA/EIA-568-B.2)
   5. Optical Fiber Cabling Components Standard (ANSI/TIA/EIA-568-B.3)
   6. ANSI/TIA/EIA-569-B Commercial Building Standard for Tele-communications Pathways and Spaces 2003.
   7. ANSI/TIA/EIA-606-A Administration Standard for the Tele-communications Infrastructure of
   8. Commercial Buildings 2002.
   9. ANSI/TIA/EIA-607-A Commercial Building Grounding and Bonding Requirements for Telecommunications 2002.
   10. ISO/IEC 11801 Generic Cabling for Customer Premises.

B. Other standards that contain requirements pertaining to the safety of and access to private and public telecommunications networks include:
   1. ANSI/NFPA 70 The National Electrical Code®, current edition.
   2. IEEE C2-2002 National Electrical Safety Code (NESC®) current edition.
   3. FCC Part 68 Code of Federal Regulations, Title 47, Telecommunications.
   4. UL 1459 Underwriters Laboratories Standard for Safety—Telephone Equipment.
   5. UL 1863 Underwriters Laboratories Standard for Safety—Communication Circuit Accessories.
   6. IEEE 802.3-2002 (10 Gigabit Ethernet for fiber)
   7. IEEE 802.5 (Token Ring)
   8. ANSI FDDI
   9. ATM at 155, 622 and 1.2Giga
   10. ANSI/TIA/EIA 854 (1000 Base Tx)
   11. ISO/IEC 8802.3 (all equivalents to IEEE 802.3)

C. If this document and any of the documents listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents; the contractor is responsible to determine and adhere to the most recent release when developing the proposal for installation.

1.04 SYSTEM DESCRIPTION

A. As a standard configuration, the system design is based on a star topology which means that each end user point will be directly connected the patch panel. Each work area communications outlet contains minimum one Category 6a jack, terminated using Category 6a horizontal cables, pulled and terminated on Category 6a insulation displacement connector fixed in a patch panels located in SDR. Patch cords/equipment cords are used to connect each jack to the appropriate service connector. Generally, high pair Category 6a cables

are also employed for analog voice connectivity that is used for non-IP communication services such as fax, K-net or emergency use. Zip twin multi-mode fiber optic cables are used as backbone/riser cables for connection between MCCR and SDR's within the school.

1.05 DESIGN ASSUMPTIONS

A. The cable infrastructure design is assuming that MCCR and BCCR will be connected through a twelve (12) cores OM3 Multimode Fiber Cable. Zip twin multi-mode fiber optic cables used to connect the edge switch of each SDR to core switch running through a vertical shaft shown in the drawings to MCCR. Those fibers are terminated in a multi ports Fiber Patch Panel.

B. For the Horizontal Distribution, Category 6a cable shall be used to connect end user point to the patch panel in SDR and to switch through patch cord with the same cable category.

C. For the External Link, the Internet Service Provider (ISP) is responsible for lying Single Mode Fiber Optic Cable connected and terminated in each MCCR in order to provide all services to the building. Moreover, the ISP shall provide the internet service as well as the connectivity to the MOC exchange to supply voice services (E1 and DID).

D. The transmission performance of a cabling system depends upon the characteristics of the horizontal cable, connecting hardware, patch cords, equipment cords, work area cords, cross-connect wiring, the total number of connections, and the care with which they are installed and maintained. The development of high-speed applications requires that cabling infrastructure be characterized by transmission parameters such as insertion loss, PSNEXT loss, return loss, and PSELFEXT which are considered in this design document to comply with applications and services that will be supported in the UTA package.

E. The cable Infrastructure solution is based on international standards to provide bandwidth needed to accommodate estimated numbers of occupants and any future expansion in order to avoid any congestion. Furthermore, Infrastructure is designed to maximize the Return on Investment (ROI) to owners in terms of reducing administrations, integrations, and future expansion cost.

F. The Cable infrastructure design is assuming compliance to the following:
   1. Redundancy
   2. Security
   3. High Availability
   4. Scalability and Expandability
   5. Quality Assurance

Part 2 - PRODUCTS

2.01 BACKBONE CABLING

A. Backbone cabling is the part of the entire cabling system which provides the connection between MCCR and SDRs in a star topology that shall have no more than two levels of connection.

B. Fiber Optic cable shall be used for the backbone interconnection between MCCR Fiber Patch Panel and SDR Fiber Patch Panel to provide a high speed and bandwidth required for data transfer between SDR and MCCR and shall accommodate growth and changes in service requirements without the installation of new cables.

C. In order to obtain the flexibility in meeting the variety of application requirements, The Contractor shall use the hierarchical star topology in the Backbone Cabling wherein each SDR patch panel is directly connected to the MCCR patch panel.

D. Fiber cable specification
   1. The Contractor Shall provide an OM3 50/125 microns Graded Index Multimode Fiber Optic Cable with laser optimized source at wavelength of 850 nm and 1310 nm which shall support 10G Base-S in the link between MCCR and SDR. Moreover, cable shall be an Indoor, Non-Conductive LSZH, tight-buffered, rodent and moisture resistance cable and shall be UL rated of OFNR (Riser).

2. The cable shall consist of LSZH Outer Jacket (125 micron) bounding an eight (8) tight-buffered (50)-micron fiber subunits each is surrounded by armed strength members and LSZH jacket which shall support 10Gbit transmission speed in a distance up to 500 m. If cables are to be longer then 500m, then single-mode fiber shall be used.
3. The fire performance of the fiber cable shall be according to the following specifications as per standards mentioned below:
    a. Fire resistant cables shall be tested according to IEC 60332.3C and shall withstand:

750 °C for 180 min. with excess loss < 1.0 dB / 0.6 m
1000 °C for 120 min. with excess loss < 3.0 dB / 0.6 m
1100 °C fire resistant cables shall withstand
1100 °C for 30 min. with excess loss < 3.0 dB / 0.6 m

    b. All cables shall be halogen-free. Halogen content and corrosivity shall be tested according to IEC 754-1 and IEC 754-2.
    c. The oil resistance properties shall be demonstrated by testing according to IEC 811-2-1, clause 10.
    d. Mud resistant cables shall have an outer sheath suitable for installation and operation in contact with mud. Mud resistant sheaths are normally not flame retardant.
4. The fiber cables shall have an operating temperature range of –10°C to +70°C. The mud resistance properties shall be demonstrated by the following test procedure: Test specimens from the outer sheath shall be immersed in the actual Mud at 70 °C and tested for elongation at break, tensile strength, volume swelling and weight increase after 14, 28 and 56 days. Requirements:
    a. Elongation at break: +40 %
    b. Tensile strength: +40 %
    c. Volume swelling: +20/-0 %
    d. Weight increase: +15/-0 %

Flamme Retardant	IEC 60332-1
Fire Retardant:	IEC 60332.3C
Low Smoke Opacity	IEC 1034 1/2
Acid Gas Emission	IEC 754-1

Table 1: Fiber Cable Fire Performance

E. Fiber Performance

1. The performance requirements for the supplied Optical Fiber channels shall assume that each Optical Fiber channel employs a single optical wavelength in one transmission window only. The main parameters that shall be used for performance testing are the Link Attenuation and Bandwidth.
2. For the link attenuation, the cable shall be tested in at least one direction at both 850nm and 1300nm in accordance with ANSI/EIA/TIA-526-14A Method B and shall be suitable for operation according to IEEE 802.3z (Gigabit Ethernet) on distances exceeding 300 m at 1300 nm.
3. The link attenuation calculation of the Optical Fiber Cable shall be based on the following constant values in addition to the parameters mentioned in table 2:
    a. 0.75 dB Connector Loss/Connector
    b. 0.3 dB Splice Loss/Splice
4. Accordingly, the attenuation test results shall be less than 2.8 dB @ 850 nm wavelength and 0.4 dB @ 1300 nm wavelength including the cable attenuation; Connector insertion loss and splice insertion loss as summarized here under:

Cabling Subsystem	Link Channel Max Length (m)	Attenuation of a Multi-mode (dB/Km)	
		850 nm	1300 nm
Building Backbone	300	2.8	0.4

Table 2: Maximum Link Attenuation

5. Moreover, the Multimode Optical Cable return loss shall not exceed 20 dB @ both 850 and 1300 nm wavelength.

F. Fiber Connectors

1. An LC pigtail shall be used for the Fiber Optic connectors with a factory polished for low insertion loss and low back reflection and shall be 100% optically tested for premium performance.
2. The connector shall meet the requirements of TIA/EIA-568-B.3 and shall comply with IEC 61754 which define the limit of loss that cable shall not exceed as mentioned here below:

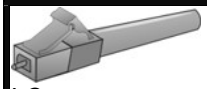
Connector	Insertion Loss	Repeatability
 LC	0.15db(SM) 0.10 dB (MM)	0.2 dB

Table 3: Types of Optical Connectors

3. The connection shall have the following typical performance:

		Insertion Loss	Return Loss
		850mm / 1300nm	850nm / 1300nm
50/125	Mean	0.3 / 0.2	27 / 29
	Limit	0.75 / 0.75	20 / 20

Table 4: Connector Performance

4. The Connection shall comply with the following mechanical and environmental test:

PARAMETER	TIA/EIA Fiber Optic Test Procedure	IEC 61300 Series Test Method	SEVERITY
Attenuation	171	3-4	n/a
Return Loss	207	3-6	n/a
Mating Durability	21	2-2	500cycles
Impact	2	2-12	8 drops at 1,5m
Plug Cable Retention/Side Pull	6	2-4	66Nat 0 degree 6,6Nat90 degree
Strength of Coupling	185	2-6	33N
Plug Cable Flexing	1	n/a	+(-)90 degrees, ,5kg 100 cycles
Plug Cable Twist	36	2-5	+(-)2,5 revolutions ,15 N
Cold	188	2-17	- 10c,96Hours Sample Functioning
Heat	4	2-18	+60 C 14days, Sample functioning
Humidity	5	2-19	+40C,90-95%RH 96 Hours Sample Functioning
Thermal Cycling	n/a	2-22	-10C to +60C 5 cycles
Vibration	n/a	2-1	10-55Hz, 30min/each axis

Table 5: Fiber Connector Mechanical Test

G. Fiber Patch Panels

1. Rack mount fiber patch panels shall be used in the SDR and MCCR facilities to connect the fiber cables to the active devices via fiber patch cords.
2. Contractor shall provide a twenty four (24) Ports Duplex Modular Patch Panels for MCCR and Twelve (12) Ports Duplex Modular Patch Panels for SDR to suit LC adapters in order to meet the full cabling system requirement of buildings Network. The Contractor shall terminate each fiber cable serving SDR & MCCR at a patch panels. The patch panels shall meet ISO/IEC 11801, EN 50173 and TIA/EIA 568 warranted component specifications and standards.
3. Contractor shall provide a 19” inch standardized chassis rack-mounted Patch Panels complete with black metallic box type modular structure, mounting screws, bend limiting clips for the cables and patch cords, cable-ties, rear port identification kit, and front built-in label kit including clear plastic holders and laser printable paper. The patch panel shall have mounting stud that accept splice trays or blown fibers. The patch panel shall have an internal routing option for providing strain relief and to maintain proper bend radius for pigtails and patch cables. It is recommended to use Color coded adapters for Multimode and Single Mode backbone fibers.

4. Moreover, Fiber Patch Panels shall have cable management, fiber management and slack storage for fiber cables to ensure that the maximum allowed bend radius is not exceeded. All connectors and adaptors must be provided with dust caps.

H. Fiber Patch Cord
   1. Fiber Patch Cords are to be used to connect active devices to the fiber backbone. Optical patch cord shall be Duplex 50/125µm OM3 type with connectors adapted to the fiber cabinet and the active devices used. (They shall be single mode, if single mode fiber is used) Fiber patch cords shall be Duplex type, with a keying system to avoid connector mismatch and shall be tested for insertion loss in accordance with TIA/EIA-455-171.
   2. Fiber patch cords shall meet the following performance:
      a. Ultra Physical Contact (UPC) finish for singlemode: Insertion loss: 0.40dB maximum, 0.20 dB typical, Return loss: minimum 55db.
      b. Physical Contact (PC) finish for Multimode 50 micron: Insertion loss: 0.50dB maximum, 0.30 dB typical, Return loss: minimum 20db.
   3. All fiber jumpers will include their FOCIS document and individual attenuation test results from the factory.

2.02 HORIZONTAL CABLING

A. Horizontal cabling is the portion of cabling system that extends from the End User outlet/connector to the horizontal Patch Panel in the SDR and shall include but not limited to the following components:
   1. Horizontal copper cable connecting each point directly to the Patch Panel of the area or floor
   2. Patch cords in the SDR.
   3. Patch cords in work area

B. The Contractor will be responsible for pulling and terminating cables following all omani and International codes, accepted industry standards and the manufacturer's instructions. The Contractor must work closely with the electrical contractor to ensure that the pathways are installed correctly and that they will allow for proper installation of the cabling system. Visual inspections and upon completion of the project test results will be used to verify proper installation practices were followed.

C. In order to comply with Owners and Unified Technology Architecture (UTA) requirements, the horizontal cabling type used in the Project shall be Category 6a (Cat 6a) cables. The contractor will be responsible for pulling the copper cable from patch panel located in the nearest SDR within the floor to service device and end user outlet.

D. The system is planned to reduce on-going maintenance and accommodate future equipment and service changes. Accommodating a diversity of user applications is considered in the design in order to reduce or eliminate the probability of requiring changes to the horizontal cabling as user needs evolve.

E. The Contractor shall ensure the distance limitation from SDR to work area outlet, which shall not exceed the 100 m distance. This distance shall include the length of SDR patch cords (5 m), the total length of cords in work area (5 m) and the horizontal run (90 m).

F. The supplied Category 6a cables shall be used for the associated connecting hardware, jumpers, patch cords, equipment cords, and work area cords and shall meet all applicable requirements including the transmission and color code specifications mentioned in ISO 11801:2002. Furthermore, Cable shall meet the transmission and color code specifications in that standard.

G. Grounding and bonding shall meet the requirements and practices of applicable authorities or codes. In addition, telecommunications grounding/bonding shall conform to ANSI/TIA/EIA-607 requirements and as per requirements mentioned in Section 3.0 Clause 3.8.

H. CAT6a Cable Specification
   1. In addition to the applicable requirements of ANSI/ICEA S-90-661, ANSI/TIA/EIA 568-B.2 and UL 444, cables shall meet the specification mentioned in those documents and as per the requirements and specifications mentioned in this document.

2. The Contractor shall provide CAT 6a Cable for the horizontal cabling which shall allow 500 MHz Bandwidth over 100 m of copper cabling and shall consists of 4 insulated conductor pairs with a twist length selected by the manufacturer to assure compliance with the transmission requirements of the TIA/EIA and ISO Standards and can be terminated in RJ-45 Connector. Each pair shall consist of 2 solid conductor commercially pure, annealed bare copper and shall meet the requirements of ASTM B 3 except that requirements for “Dimensions and Permissible Variations” are not applicable. The conductors shall be per ASTM B 258 except for dimensions. Each copper conductor shall be insulated 100% with Teflon FEP Fluor- polymer resin, but may include FEP concentrate color additives. There shall be no splices of the insulated conductor. The core, consisting of 4 insulated conductor pairs, shall be protected with an overall thermoplastic covering generally referred to as an “outer jacket.” The jacket shall be LSZH, and shall meet and maintain the physical and mechanical requirements of ASTM D4565 for the expected life of the cable.
3. The ultimate breaking strength of the cable, measured in accordance with ASTM D4565, shall be 400 N (90 lbf) minimum. Twisted-pair cables shall withstand a bend radius of 30 mm at a temperature of -20 °C ± 1 °C, without jacket or insulation cracking, when tested in accordance with ASTM D4565, Wire and Cable Bending Test. Cables shall have an operating temperature range of –20°C to 125°C in accordance with UL 444. Pulling tension should not exceed 25 LBF or that which is recommended by the cable manufacturer.

I. CAT6a Cable Performance

1. All pairs must have impedance of 100 Ohms, with a tolerance of +/- 12 ohms. Insulators in standard Blue/White, Orange/White, Green/White, Brown/White colors must cover the conductors.
2. The cable shall meet the general and environmental specification as mentioned here below:
    a. 1.0-100MHz Impedance (ohms) 100 ± 12
    b. 100-350MHz Impedance (ohms) 100 ± 15
    c. 350-750.0MHz Impedance (ohms) 100 ± 22
    d. 1.0-750.0MHz Delay Skew (ns/100m) <=25
    e. Pair-to-Ground Capacitance Unbalance (pF/100m) <=330
    f. Max. Conductor DC Resistance 20oC (ohms/km) 93.8
    g. Resistance Unbalance (%) <=3

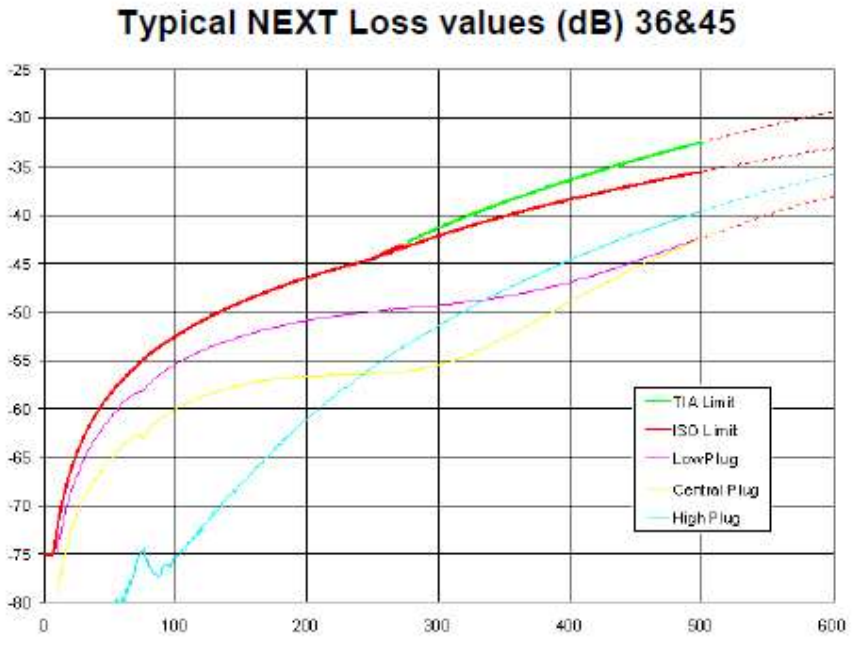
3. The maximum application frequencies shall be based on required permanent link and channel characteristics, and shall not be indicated by the maximum specified frequency for the cabling. In the following table, the Minimum or Maximum requirements for attenuation, NEXT loss, Power Sum NEXT loss, ACR, Power Sum ACR, Return loss and Power Sum ELFEXT are shown as per cable requirements of FCD ISO/IEC 11801 standard for discrete frequencies only. Transmission requirements shall also be met for all intermediate frequencies. Requirements at intermediate frequencies are derived by linear interpolation between frequencies on a semi-logarithmic (NEXT loss, Power Sum NEXT loss, ACR, Power Sum ACR, ELFEXT and Power Sum ELFEXT) or logarithmic (attenuation) scale.

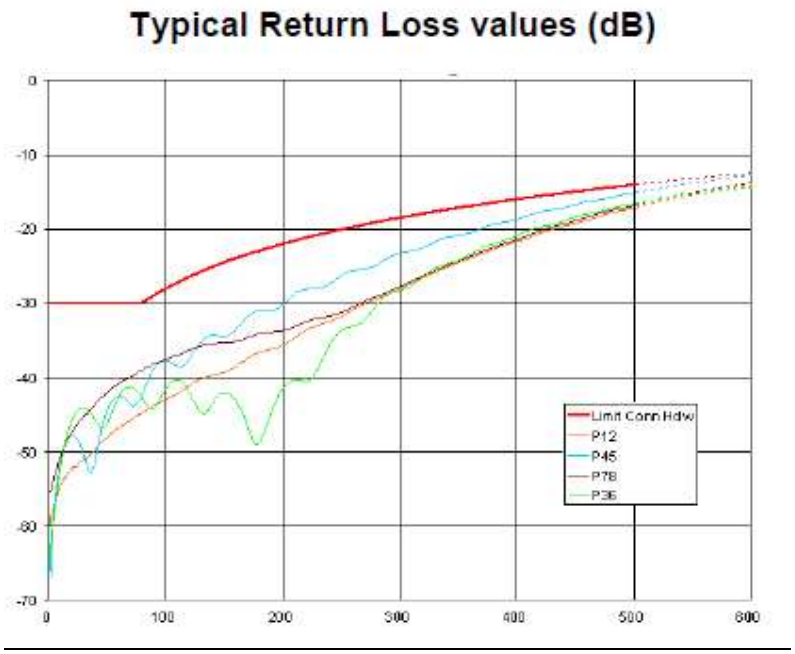
CAT 6 Loss Characteristics

Frequency (MHz)	Return loss (Min dB)	Attenuation Max (dB/100m)	NEXT (Min dB)
1	20.0	2.0	78.3
4	24.2	3.7	69.3
8	26.3	5.2	64.8
10	27.0	5.9	63.3
16	27.0	7.4	60.2
20	27.0	8.3	58.8
25	26.3	9.3	57.3
31.25	25.6	10.4	55.9
62.5	23.5	14.9	51.4
100	22.1	19.0	48.3
155	20.8	24.0	45.4
200	20	27.5	43.8
300	18.8	34.2	41.1
400	17.9	40.0	39.3
500	17.5	45.3	37.8
600	16.9	50.1	36.6

J. CAT6a Connectors

1. All jacks shall be wired to the T568A and T568B wiring pattern. Jacks shall be constructed with a housing of polyphenylene oxide, 94V-0 rated. The connector shall terminate 23 AWG solid conductors with a maximum insulation diameter of 0.050 inches. The jack contacts shall be plated with a minimum of 50 micro-inches of gold in the contact area over a 50 micro-inch minimum nickel under-plate. Jacks shall be compatible with panel thicknesses of 0.058” - 0.063”. Jacks shall snap into a 0.790” X 0.582” opening.
2. Category 6a jacks shall be 4-pair and shall meet the performance requirements listed in the table below. Jacks shall fit in a 0.790” X 0.582” opening. Each jack shall be wired to T568B. Jacks shall be UL Listed.
3. The Jack shall meet the following performance characteristics:





K. CAT6a Patch Cords

1. Cat.6a copper patch cords are to be used to connect the Copper patch panel with the workstations to RJ45 outlets, and allow for patching in the enclosures between patch panels and active devices. They shall meet the following criteria:
    a. Factory made. (hand crimping of cable is not acceptable)
    b. Minimum length of 3 ft or 0.97 m, and maximum length of 5m.
    c. Third party component verified to the standard for Category 6a ANSI/TIA/EIA 568 B 2.1.
    d. Compliant to channel ISO 11801 Class EA and Channel TIA 568B.2-10 Category 6A performances.
    e. Center tuned to cat.6 test specifications. (Perfectly centered in relation to the limit values set by standard ANSI/TIA/EIA-568-B.2.1.
    f. Manufactured from stranded wire cable.
    g. Have a “Snag-Less” design to protect plug tabs from damage during moves and installs.
    h. Be available in various colors and allow the use of color icons.
    i. Rated for at least 750 plug insertions.
    j. Fire resistance IEC 60332-1
    k. Toxicity/Corrosion IEC 60754-1.
    l. Modular contacts must be plated with 50 micro inches of gold.

L. CAT6a Patch Panels

1. The Contractor shall provide a 24/48 ports modular patch panel which shall be equipped with the same CAT6a connector as specified in the previous section. Patch panel shall also have 19" equipment practice dimensions to permit mounting in standard cabinets, racks or bays and shall be available to take a minimum of 24 copper jacks per 1U. The patch panel shall be Category 6a RJ45, third party component verified to cat.6a ANSI/TIA/EIA 568 B 2.1 of 20 June 2002.
2. The presentation of the patch panel shall provide a built-in labeling using clear plastic holders and laser printable paper. If blains, circuit cross over or impedance matchers are used, these shall be external to the patch panel. The connector shall provide T568B color code identification.
3. The panels shall be designed for keystone fitting of jacks/ sockets and shall have cable management and tie down points for copper cable. The Connection of the cable shall be done through rear IDC contacts with use of a standard 110 impact tool.
4. If angled panels are to be used, they must be recessed from the 19” rails, and meet all requirements above.

M. Cable Marking and Identification
    1. Cable shall be UL/cUL listed under file number E138034 and the contractor shall submit a compliancy statement of third party verification.
    2. The cable jacket shall be legibly marked at least every 24 in. by surface printing. The following information shall be provided:
        a. Manufacturer's Identification
        b. Type of Cable Construction
        c. UL/cUL or ETL Verification
        d. Jacket type Identification Code
        e. Cable Footage Marker

2.03 WORK AREA

A. The Work Area shall also include the wall plate itself, connectors, even the adapters that link cabling to wall outlet. It shall be designed to tolerate frequent moves but with careful management.
B. Work Area Outlet
    1. Outlets are used to connect user equipment to the network through a patch cord. The Contractor shall provide a compatible outlet that facilitates the termination of multiple horizontal cables in a common location. Work area cables originating from the Outlet shall be routed through work area pathways and shall be connected directly to work station equipment without the use of any additional intermediate connections.
    2. Outlets shall be located in fully accessible, permanent locations such as building columns, permanent walls, and floor and shall not be located in ceiling spaces, or any obstructed area. Moreover, Outlets shall not be installed in furniture unless that unit of furniture is permanently secured to the building structure.
    3. The presentation of faceplate shall support a built-in labeling using a clear plastic holders and laser printable paper.
    4. The RJ45 modules shall meet the following criteria:
        a. Category 6a RJ45, third party component verified to Cat.6 ANSI/TIA/EIA 568 B 2.1. A new certificate shall be provided
        b. Center tuned to Cat.6 test specifications. (Perfectly centered in relation to the limit values set by standard ANSI/TIA/EIA-568-B.2.1. of 20 June 2002.)
        c. Compliant to FCC part 68, subpart F and UL1863, dealing with the interface's physical dimensions, including the 1.27µm gilding on the contacts, the traction force that has to be borne by the RJ45 socket, the plug (100 grams) and the maximum force authorized for connecting the plug in the jack (2.2 kg).
        d. Support T568A and T568B wiring.
        e. Available in various colors, and be icon compatible.
        f. Enable maximum untwisting of ½ inch (1,2cm) of the pairs.
        g. Connection the cable will be done through rear IDC contacts with use of a standard 110 impact tool. (Tool less connectors is not acceptable).
        h. Modular contacts must be plated with minimum 50 micro inches of gold.
C. Modules that cannot be re-connected in case of error are not acceptable.

2.04 ANALOG CONNECTIVITY

A. As the whole network infrastructure is an IP based Network, The Contractor shall provide analog connectivity for different applications, such as Emergency telephone lines, faxes and K-Net through CAT6a cable which shall run through the backbone shaft to connect the MOC/ISP gateway in MCCR with the media gateway located at each SDR.

B. A bundle of CAT6a multi-pairs shall be pulled from the MCCR copper patch panel to each SDR copper patch panel and connected to the A/D converter to support the number of analog connectivity required for that floor where each pair shall support single analog connectivity.

C. The Multi-pairs Cat6a cable shall be terminated in a patch panel in a floor to support the analog connectivity for the floor and the floor above.
    1. Other cable markings shall include:
        a. Standards Verification
        b. Number of pairs

c. Part number
d. Manufacturer's Identification
e. Type of Cable Construction
f. Cable Footage Marker

2. The cables shall withstand a bend radius of 30 mm at a temperature of -20 °C ± 1 °C, without jacket or insulation cracking, when tested in accordance with ASTM D4565, Wire and Cable Bending Test. For certain applications, the use of cables with a lower temperature bending performance of -30 °C ± 1 °C shall be considered. The minimum breaking strength of the cable, measured in accordance with ASTM D4565, shall be 400 N (90 lbf) minimum.
3. The Flame Spread Index of CAT6a cable provided shall not be greater than 25 derived from the spread of flame versus time in accordance with NFPA 255 "Standard Method of Surface Burning Characteristics of Building Materials" while the Smoke Developed Index shall not be greater than 50 derived from measurements of smoke obstruction versus time in accordance with NFPA 255 "Standard Method of Surface Burning Characteristics of Building Materials" and shall be indexed to red oak. As for Potential heat, it shall not be greater than 3500 BTU/lb (8141kJ/kg) which is measured in accordance with NFPA 259, Standard Test Method for Potential Heat of Building Materials".

2.05 PATHWAY AND ROUTES:

The cable run from the SDR to each point shall be through a direct connection using under floor trunk and ceiling cable tray divided into compartments to separate different type of cables (Fiber Optic, Copper, Spare) with minimum of 30 cm from the electrical cable. The trunk shall be grounded to get rid of the current that is produced from electromagnetic wave even from copper or electrical cables to avoid the effect on data running in the copper cable.

2.06 NETWORK CABINET (STEEL CABINET)

A. The Contractor shall provide a closet that houses Active equipments, backbone and horizontal cabling equipment, and associated pathways for the cable in addition to the most auxiliary equipment including but not limited to security systems, key-entry systems, file servers, etc. Specific closet sizes shall be based on service-area size which shall ensure a sufficient space for all connecting hardware, as well as enough room for service personnel to function without causing undue system disruptions.

B. The cabinet's installation shall comply with ANSI/EIA-310-D-Specifications for Equipment and Racks, ETSI and DIN 41494. The cabinets shall be free-standing types for the Main Central Room and Sub Distribution Rooms.

C. Cabinets shall meet the requirements of accommodating high volume of cabling 19" 24/48-port patch panels and the Active components equipment. It shall be steel and powder coated cabinets, Ventilated top cover, with removable side panels and Castors heavy duty broke.

D. The Cabinets shall be made of rust-free aluminum, with a black powder coat finish to minimize fingerprints and resist scratching. In case racks are assembled together, they must be separated by 10" wide cable management cages. (instead of the 6" wide)

E. The standard 42U cabinet size is 800 mm x 800 mm and 1200 mm X 800 mm shall have the following features:
1. 19"format, front and back. The rack's spaces (units) must be stamped every unit.
2. Supports both passive and active equipment
3. Have 10" wide vertical management cages, with individual plastic 1-rack unit fingers, include spools and bend limiting clips. The cages will be covered by double hinged aluminum doors. Clip-on panels are not acceptable
4. Have a top trough with built-in waterfall providing bend radius control and efficient patch cable routing.
5. Provides cable entry from top, sides, back and bottom
6. Permits a minimum load of 250kg
7. Consist of a right/left handed door
8. The front and back doors shall be perforated for better cooling
9. Accommodates both 19" and ETSI equipment
10. Contains lockable side panels
11. Allocates Castor-Leveler combination
12. Contains cable management rings and panels

13. Fully assembled and configured from the factory
14. Allows for future growth
15. Comply with the following standards:
    a. DIN 41494, Part 7
    b. DIN 41491, Part 1
    c. EN 60950
    d. IEC 297-2
    e. VDE 0100
16. On the other hand, each rack shall supply 13 power strips; these power strips shall have the following features:
    a. Illuminated Power Switch
    b. 45 Degree Angled Socket
    c. Modular construction using polycarbonate sockets
    d. CE Marked
    e. Fully earthed construction with an external earth facility
    f. Clips to prevent accidental switching
    g. Conform to BS 5733/VDE 620

CHAPTER 08
SOLAR SYSTEM

CHAPTER 13
SOLAR SYSTEM

1. ABBREVIATIONS

PV	Photovoltaic
IEC	International Electrotechnical Commission
I EEE	Institute of Electrical and Electronics Engineers
NEMA	National Electrical Manufacturers Association
ASTM	American Society for Testing and Materials
UL	Underwriter's Laboratories
NFPA	National Fire Protection Associations
NEC	National Electrical Code
DSR	Distribution Submittal Requirements
ssPV	Small Scale Photovoltaic
STC	Standard Testing Conditions
GCR	Global Competition Review
PCC	Plain Cement Concrete
RCC	Reinforced Cement Concrete
MPPT	Maximum Power Point Tracking
SPD	Surge Protection Device
DAS	Data Acquisition System
ROQ	Recommended Order Quantity
BOM	Bill Of Material

2. SCOPE

The work covered by this specification includes site survey, design, engineering, fabrication, testing, delivery to the site, installation (civil, mechanical, electrical...etc.), supervision, training (if required), start-up, commissioning, and putting into successful operation for photovoltaic (PV) system.

The PV system shall have capacity according to design drawings and as per calculated demand power load, and shall have the electrical operation parameters as same as the local connected network.
Contractor should provide shop drawings for PV module:

1. Include plans, elevations, sections, and mounting details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, and required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly.
4. Include diagrams for power, signal, and control wiring.

The Photovoltaic system shall include, but not limited to, the following:
A. Photovoltaic modules and array system
B. Supporting structure and walkway including handrails
C. Hybrid Inverter(s)
D. Inverter distribution panels
E. Protection and metering system.
F. Data acquisition and analysis system ‘
G. Cables and raceways.
H. Surge suppression, earthing and bonding system.

3.0 QUALITY STANDARDS

3.1 General

The quality of items and services supplied by Contractor shall be controlled to meet the requirements of this Specification, referenced codes and standards and other Contract Package documents refer to Chapter One (1) basic electrical requirement.

3.2 Warranty

A. Manufacturer's Special Materials and Workmanship Warranty: Manufacturer agrees to repair or replace components of PV modules that fail in materials or workmanship within specified warranty period.

1. Manufacturer's materials and workmanship warranties include, but are not limited to, the following:

   a. Faulty operation of PV modules.

   b. Faulty operation of hybrid inverter.

2. Warranty Period: five years from date of Substantial Completion.

B. Manufacturer's Special Minimum Power Output Warranty: Manufacturer agrees to repair or replace components of PV modules that fail to exhibit the minimum power output within specified warranty period. Special warranty, applying to modules only, applies to materials only, on a prorated basis, for period specified.

1. Manufacturer's minimum power output warranties include, but are not limited to, the following warranty periods, from date of Substantial Completion:

    a. Specified minimum power output to 80 percent or more, for a period of 25 years.

3.3 Codes and Standards

3.3.1 The requirements of this Specification are based on the conformance with the following, FC, US Codes and standards as a priority as stated.

3.3.2 In case of conflict between performance or design characteristics given by the various codes and standards agencies that cover a common area of equipment and/or design and this Technical Specifications, the matter should be referred to the Distribution Company.

3.3.3 Referenced Codes and Standards

The requirements of this specification are based on the conformance with the following Codes and standards.

EEC 60364-44	Low voltage electrical insulations - Part 44: Protection for safety - Protection against voltage disturbances and electromagnetic disturbances.
IEC 60898-2	Circuit-breakers for overcurrent protection for household and similar installations - Part 2: Circuit-breakers for AC and DC operation
IEC 60904-1	Photovoltaic devices - Part I: Measurement of photovoltaic current-voltage characteristics.
IEC 60904-2	Photovoltaic devices - Part 2: Requirements for reference solar devices.
IEC 60904-8	Photovoltaic devices - Part 8: Measurement of spectral response of a photovoltaic (PV) device.
IEC 60947-2	Low-voltage switchgear and control gear - Part 2: Circuit-breakers.
IEC 61215	Crystalline silicon terrestrial photovoltaic (PV) modules-Design qualification and type approval.
IEC 61277	Terrestrial photovoltaic (PV) power generating systems - General and guide.
IEC 61439	Low Voltage Switchgear and Control gear Assemblies.
IEC 61683	Photovoltaic systems - Power conditioners - Procedure for measuring efficiency.

IEC 61721	Susceptibility of a photovoltaic (PV) module to accidental impact damage (resistance to impact test).
IEC 61724	Photovoltaic system performance monitoring - Guidelines for measurement, data exchange and analysis.
IEC 61727	Photovoltaic (PV) systems - Characteristics of the utility interface.
IEC 61730	Requirements for construction, testing and safety qualification.
IEC 61829	Crystalline silicon photovoltaic (PV) array – Onsite measurement of I-V characteristics.
IEC 62093	Balance-of-system components for photovoltaic systems - Design qualification natural environments.
IEC 62109-1	Safety of power converters for use in photovoltaic power systems - Part .1; General requirements.
IEC 62109-2	Safety of power converters for use in photovoltaic power systems - Part 2: Particular requirements for inverters.
IEC 62446	Grid connected photovoltaic systems – Minimum requirements for system documentation, commissioning tests and inspection.
IEC 62548	Design requirements for photovoltaic (PV) arrays.
IEEE 928	Recommended criteria for terrestrial PV power systems.
IEEE 1374	Guide for terrestrial PV power system safety.
IEEE 1547	Interconnecting Distributed Resources with Electric Power Systems.
NEMAAB-I	Molded Case Circuit Breakers and Molded Case Switches.
ASTM E 1036	Standard Test Methods for Electrical Performance of Non-concentrator Terrestrial Photovoltaic Modules and Arrays Using Reference Cells
ASTM E 1171	Test Methods for Photovoltaic Modules in Cyclic Temperature and Humidity Environments.
ASTM E 1799	Standard Practice for Visual Inspections of Photovoltaic Modules.
ASTM E 1802	Standard Test Methods for Wet insulation Integrity Testing of Photovoltaic Modules.
ASTM E 1830	Standard Test Methods for Determining Mechanical Integrity of Photovoltaic Modules.
ASTM E 2047	Standard Test Method for Wet Insulation Integrity Testing of Photovoltaic Arrays.

NFPA 70	Instrument Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources.
UL 1741	Flat-Plate Photovoltaic Modules and Panels.
UL 1703	National Electrical Code.

4.0 SERVICE REQUIREMENTS

All equipment supplied shall have properly function under the site conditions, e.g. ambient air temperatures, humidity, and seismic loads, specified in "Technical Requirements for Connecting Small Scale PV (ssPV) Systems to Low/Medium Voltage Distribution Networks" by Lebanese Electric Utility and Consumer Protection Regulatory Agency.

4.1 All equipment shall be fully operational in the following conditions:
- Relative humidity up to 95%
- Ambient temperature from 10ºC to 45ºC
- Rural environment with high presence of dust, insects, etc.

4.2 External equipment shall additionally withstand the following conditions:
- High ultra violet radiation
- Wind speeds up to 120 km/h

4.3 The ability of the equipment of the same basic design and size to operate correctly in the indicated environmental and climatic conditions shall be proven by appropriate documentation on successful operation of at least 5 years.

5.0 DESIGN REQUIREMENTS

5.1 General

5.1.1 The Photovoltaic system shall be Grid connected to operate in parallel with the 400 VAC auxiliary system of the distribution company power plant to feed the grid. Means to prevent the reverse power to the PV plant or circulating current between the two sources are required.

5.1.2 The Photovoltaic system shall be designed to efficiently use the available space to generate the maximum output kWp DC at standard testing conditions STC and to generate the maximum allowable annual energy.

5.1.3 During grid power supply, the PV generation helps to reduce the consumption from the utility grid by supplying the load of the facility and charging the battery and use a mix of renewable energy and non-renewable energy to charge batteries, as well as potentially in the future, back-feeding to the grid any excess power.

5.1.4 During grid power cuts, power will be taken directly from DC side (PV generator and the Battery) to fill the gap and to provide backup electrical supply to all connected loads as per design.

5.1.5 Hybrid invertor should include all needed operation modes and priority and shall meet client requirements as much as possible, these modes and priorities could be selected by the end user according to the actual usage, so as to maximize the benefit of using the solar energy system, and according to the state of PV plant and condition as of the day, and all data must be recorded to validate the optimum strategies of operation.

5.1.6 The contractor is responsible for site survey and Takes, the necessary measurements to perform the calculation, and Photovoltaic system sizing and response for building safety against mechanical loads of the PV system.

5.1.7 The Contractor shall determine the most efficient mounting parameters of the PV arrays (Tilt, the orientation …etc.) to maximize the solar energy exposure, and minimize the shade from the other equipment.

5.1.8 The PV arrays shall be uniformly arranged, and any cabling, raceways, junction boxes and other balance of system equipment shall be arranged and installed considering the access ways for maintenance requirements as recommended by the manufacturer.

5.1.9 The mounting of the PV array's shall take into consideration the requirement of the maximum allowed air circulation for the PV modules natural cooling as required by the PV modules specifications.

5.1.10 The photovoltaic system arrangements shall be designed for easy maintenance.

5.2 Photovoltaic modules and Array system

5.2.1 The PV modules shall comply with the norm IEC 61215 edition 2, and IEC 61646 and shall be qualified to and be classified by Class according to IEC 61730-1 and IEC61730-2. PV Modules must satisfy

Safety qualification IEC 61730 & IEC 60364-4-41 for protection against electric shock or equivalent.

5.2.2 PV modules shall contain crystalline silicon cells either, mono, where thin film or any other material shall be subjected to the distribution company approval with plug and play water proof connectors, high transmission tempered glass, aluminum frame and adequate bypass diodes protection.

5.2.3 The connection to a module shall be arranged so that removal of a module or panel from a photovoltaic source circuit does not interrupt a grounded conductor to other PV source circuits.

5.2.4 PV generator junction and fuse boxes are exposed to the environment, contractor shall provide ready made junction box, and shall be at least IP 65 with UV resistant. The terminals must be clearly marked with + and – for the corresponding connections. Connections shall be of a screw type with a capacity of at least two 4 mm2 wires.

5.2.5 The combiner box should have a provision for opening for replacing the cables.

5.2.6 PV modules shall be dust repel and capable of resisting damage/water penetration when subject to varying weather conditions including dust, sand, rain, washing liquids and similar intermittent external conditions.

5.2.7 PV modules must be warranted for their output peak watt capacity, which should be with linear degradation not less than 90% at the end of 10 years and 80% at the end of 25 years starting from operating date of the PV system.

5.2.8 PV modules shall be operating with ambient temperature from -10 to 60℃.

5.2.9 The expected life time for PV modules is 25 years.

5.3 Supporting structure and walkways

5.3.1 There should preferably be a fixed arrangement (stand) for mounting the module in the direction facing the sun to obtain the maximum peak power output during year.

5.3.2 PV modules, module mounting fames, access walkway and the methods used for attaching frames to buildings shall be rated for the maximum wind speeds in the site.

5.3.3 Support structures and module mounting arrangements should comply with applicable building codes regulations and standards and module manufacturer's mounting requirements.

5.3.4 Provisions should be taken in the mounting arrangement of PV modules to allow for the maximum expansion/contraction of the modules wider expected operating temperatures, according to the manufacturer's recommendations. Similar provisions should be taken for other applicable metallic components, including mounting structures, conduits and cable trunks.

5.3.5 Module mounting frames, and the methods used for attaching modules to frames and frames to building shall be made from corrosion resistant materials suitable for the lifetime and duty of the system. The support structure used should be refabricated hot dip galvanized steel or, treated aluminum (anodized, oxidized…etc.).

5.3.6 Detailed specifications for the mounting structure are given below:

Bolts, nuts, fasteners, panel mounting clamps	Stainless steel SS 304
Mounting arrangement for RCC-flat	With removable concrete ballast made of pre-fabricated PCC (1:2:4), ensuring that the roof remains water proof and ensuring stability and wind withstanding capacity (if required)
Mounting arrangement for metal sheet	Mounting directly on the sheet metal, ensuring stability and wind withstanding capacity, or penetrating the sheet metal and fixing to the sub-structure, ensuring that the roof remains water proof and ensuring stability and wind withstanding capacity.
Mounting arrangement for elevated structures	The elevated structure has to be securely anchored to the supporting surface. Concrete foundations of appropriate weight and depth for elevated structures mounted directly on the ground; Bolted with anchor bolts of appropriate strength for elevated structures mounted on RCC surfaces.
Mounting arrangement for ground installations	With RCC layer above pre-fabricated PCC (1:2:4) concrete ballast; assuring enough ground clearance to prevent damage of the module through water, animals and other environmental factors.
Minimum horizontal distance between roof barbet and mounting	0.6m and depend on the site condition

structure	
Access for panel cleaning and maintenance	All solar panels must be accessible from the top for cleaning and from the bottom for access to the module junction box.

5.4 Protection and Metering system:

5.4.1 Protection against electric shock in the DC side shall be achieved by extra-low voltage (SELV systems) together with components and systems classified as Class III or better and galvanic isolation or equivalent of the inverter. For the AC side, protection by double or reinforced insulation between any live conductor and any earthed or exposed conductive part is required.

5.4.2 Protection against fire:

Direct current systems, and photovoltaic generators in particular, pose various hazards in addition to those derived from conventional A.C. power systems, for example the ability to produce and sustain electrical arcs with currents that are not much greater than normal operating currents. A fire-fighting extinguisher for electrical fires shall be provided attached to the cabinet.

5.4.3 Protection against over current:

Protection against over current in strings: Fault currents due to short circuits in modules, in junction boxes or in module wiring or earth faults in wiring can result in over current in a PV generator. PV modules are current limited sources but because they also connected to batteries, they can be subjected to over currents caused by either multiple parallel adjacent strings or from external sources or both. For this reason, over current protection in each string is required.

PV generator over current protection: PV generator cable over current protection shall be installed between the battery and the charge controller as close as possible to the battery or DC bus bar.

Battery over current protection: Battery cable over current protection shall be installed between the battery and the DC bus bar as close as possible to the battery.

5.4.4 Protection against effects of lightning and surge over-voltage

DC side: The installation of a PV generator on a building has a negligible effect on the probability of direct lightning strikes; therefore,

it does not necessarily imply that a lightning protection system should be installed if none is already present.

Damage caused by over-voltage is ultimately due to the failure of insulation between live parts or between live parts and earth. The intention of over-voltage protection is to equalize all exposed metallic sections of an installation to a common potential during the event of an over-voltage. Equipotential bonding is therefore required as an important over-voltage protection measure and shall be done in accordance with recognized standards or acceptable state of the art.

To avoid the formation of wiring loops between earthed conductors and D.C. cabling, equipotential bonding conductors should run parallel and as close as possible to the D.C. cabling. It is also recommended to branch the bonding conductor to run parallel with all the D.C. cabling branches.

AC side: Nevertheless, electronic components used in this back up application have to be protected from surge overvoltage coming from the EDL exposed grid cables (outdoor-cables) during storms.

5.4.5 A blocking diode shall be provided to block reverse flow of current into a photovoltaic source circuit (if required) according to distribution company requirements.

5.4.6 Suitable circuit breakers should be provided for isolating the PV system from the loads both in the DC side and the AC side.

5.4.7 The PV system shall be protected against overcurrent and short circuit by using suitable circuit breakers these circuit breakers are certified to either IEC60898-2 or IEC 60947-2.

5.4.8 The Contractor is responsible to set the protection setting point according to the equipment manufacturers' specifications

5.4.9 The cables from the array strings to the solar grid inverters shall be provided with DC fuse protection. Fuses shall have a voltage rating and current rating as required. The fuse shall be housed in thermoplastic IP65 enclosures with transparent covers.

5.4.10 Battery management system may be required depending on every system's specific needs, BMS should read each individual cell voltage and temperature, current, resistance, and communicate with the monitoring equipment, also to manage and operate within system safe limits. BMS system is required only if mentioned in BOQ.

5.5 Inverter(s)

5.5.1 Inverter shall be in compliance with IEEE-1547, IEC 62116, IEC 61727, and IEC 62109-1, 2, also with VDE-AR-N 4105, G83/2, and shall be listed for the PV application as per NFPA 70

5.5.2 Contractor shall submit conversion efficiency data tested by an International Recognized Testing Laboratory, the conversion efficiency data is from testing on a minimum of five samples; at least 97% efficiency is required.

5.5.3 The inverter shall be equipped with the following:

A. Input and output disconnecting means, including integrated circuit breakers and sub combiners.
B. Maximum Power Point Tracking (MPPT). (The Maximum Power Point tracking (MPP) range of the inverters should incorporate the MPP points of the arrays I-V curve at different temperatures). The Maximum Power Point tracking (MPP) efficiency should be at least 97%.
C. Anti-islanding features.
D. IP65 enclosure for outdoor applications with sun shed and IP54 for indoor application.
E. For each inverter there should be communication interface via Bluetooth und providing a modern laptop with the corresponding program installed on it.
F. The Inverter shall be provided with build in UI monitor display the electrical parameters. In addition, environmental data - like ‹nodule temperature, ambient temperature, solar radiation, wind speed shall also be logged, stored and analyzed.

5.5.4 The operating range of the inverter should match the 1-V characteristic of PV arrays.

5.5.5 The inverters shall be capable of producing three phase true sine wave at an output of 400/230 volts with maximum * 10% variation and 50 Hz frequency (48.5 -51 Hz). The inverter maximum efficiency shall be at least 97% and the tenderer should indicate the loading corresponding efficiency range. The Total Harmonic distortion shall be limited to 5%. The injected direct current and shall be limited to 0.5% the alternating current nominal value.

5.5.6 A solar priority function which adjusts the instantaneous power consumed from the source according to the battery voltage. The operation of the solar priority function shall be done with an automatic adjustment algorithm of the input limit current. The input limit current is decreased, if there is enough energy available at the

DC side, from the initial value. The lower the input current, more power to the load is provided from the dc side by the boost function. A boost function which can add power from the dc side to the ac source from the grid according to the input limit current that shall be configured.

5.5.7 Inverter shall be installed with sun shed provided by contractor.

5.5.8 If the inverter protected with password to manage the software, then Distribution Company should be provide with this password.

5.5.9 Inverter shall be operating and withstanding ambient temperature from -5:60 degrees Celsius.

5.5.10 The inverter warranty is 5 years.

5.6 Cables and raceways

5.6.1 DC Cables of PV system shall be in accordance with IEC 62548.

5.6.2 The overall voltage drop from the most remote module in the array to the terminals of the application circuit should not exceed 2% of the PV array voltage at its maximum power point.

5.6.3 Contractor shall design, furnish, install and test all power and control cables between Contractor's equipment/panels.

5.6.4 Contractor shall install all raceway systems (cable trunk, exposed conduits…etc.) for all cables and wiring furnished by the Contractor. All raceway system including cable trunks and conduits shall be hot dipped galvanized steel. (Minimum height froth ground level should be 10cm).

5.6.5 To protect connection cables against UV sunrays and high temperature, the power outdoor cabling shall be made of copper conductors with double sheath type HO7RNF inside XLPE or PVC pipes and inside cable trunk.

5.7 Lithium-Ion Batteries

5.7.1 Application:

The battery feeds the priority loads during black outs in the daytime, while being charged by the photovoltaic generator. The specifications of the batteries will vary depending on the requirements mentioned in the BOQ for each of the different sites. (Best scenario).

The battery shall have at least the rated capacity specified in the drawings at the C100 discharge rate according to DIN 43539-9.

5.7.2 Battery performance:

The battery shall have a self-discharge when new of less than 5% per month (at 25oC and fully charged) of its rated capacity.

The battery shall have a Columbic efficiency of at least 85% and energy conversion efficiency of at least 85% when new and charged to more than 50% of capacity.

The battery cycle life for discharge/charge regular cycles down to 75% DOD shall be more than 1000 cycles (According to IEC 896-1).

5.7.3 Labeling:

On each battery the following information has to be provided:

- Manufacturer
- Serial number
- Rated capacity C100
- Manufacturing date
- Clear indication of the positive and negative pole
- Clear indication of maximum and minimum electrolyte level
- Safety warning

5.7.4 Data sheets:

Full technical data sheets shall be provided in the offer. These must include:

- Curves showing rated Ah capacity at several discharge rates from C10-C100
- Cycle life versus depth of discharge
- Self-discharge characteristics
- A table of hydrometer readings from discharge to full charge
- Physical size and weight
- Details of the materials used in construction.

5.7.5 Design is done based on the below batteries specifications:

- Approx. Dimensions: 25-30cm x 47-52cm x 20-25cm (D x W x H)
- Amp Hours: 300Ah
- Voltage: 12 Nominal
- Life Expectancy: 3000-5000 Cycles @ 100% DOD
- Life Expectancy: 3000-5000 cycles
- Capacity at Different Cycles (%)
    - 100 cycles 99.7

    - 500 cycles 96.3
    - 1000 cycles 90.8
    - 1500 cycles 85.4
    - 2000 cycles 80.1
- Weight: 84lbs / 37.7 kg
- Efficiency: 99%
- Minutes at 50A: 360
- Memory: None
- Maintenance: None
- Max Continuous Charge: 80A Max
- Continuous Discharge: 80A
- Peak Charge/Discharge: 350A (3sec)
- Operating Temperature: -4 + 158 F / -20 + 70 C
- Auto Low Voltage Cutoff: 8V
- Auto Over Voltage Cutoff: 16V

5.8 Batteries Technical Cabinet

5.8.1 Batteries technical cabinets or enclosures should be used to provide a degree of protection to personnel against access to hazardous parts, and should be used also to provide a degree of protection of the batteries inside against ingress of solid objects, water and other weather conditions

5.8.2 Contractor shall provide Nema 1R battery technical cabinet where located inside locked rooms otherwise Nema 3R should be provided technical cabinet must be carbon steel with powder coated finish and concealed door hinges, size should hold all batteries needed on site.

6.0 MANUFACTURERS

All equipment shall be free from rust, scale, manufacturing residue and foreign material to the extent that it can be put into operation without further cleaning. All work performed at the job site on the equipment in connection with repair or replacement of defective materials or components shall be performed by Contractor or others under the supervision of the Contractor.

7.0 GROUNDING AND BONDING:

Refer to Chapter Six (6)

8.0 SPARE PARTS

The contractor shall submit in his offer the recommended spare parts for different system components, based on his previous experience with similar system, the spare parts list should include as Distribution Company required of the total supplied modules and as Distribution Company required of the total supplied fuses of both the AC and DC connections.

9.0 Execution

9.1.1 Examine substrate areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

9.1.2 Field Quality Control:

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. PV module will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports for consultant approval.

A. Testing and commissioning for the lighting solar system.

CHAPTER 09
BELL SYSTEM FOR CLASSES
(End of Session)

A. GENERAL

The Contractor shall supply and install complete Class Bell System with quartz clock, bell, bell pushes, conduits, wires, boxes, accessories etc.

Pressing a bell push shall ring the bells for a predetermined time as an override for the clock.

Cover plates to bell pushes shall be similar to those of other devices used.

Conduits, trunkings, boxes and accessories shall comply with the relevant clauses of these specifications. Conduits shall be completely separate from other system conduits.

Bell locations as shown on the drawings are approximate.

Final locations shall be approved by the engineer.

The bell shall be of 20cm diameter, vibrating type, dust proof, surface mounted.