

F3 GENERAL SPECIFICATION FOR BUILDING CONSTRUCTION AND REHABILITATION WORK

F3.1 Brickwork

F3.1.1 General

Brickwork shall consist of supply and transport of all materials (including mortar) and execution of brickwork (with bricks/and light weight Concrete blocks) protection as well as secondary work.

All bricks shall be new and of the best quality of their respective kinds. They shall be clean, hard, sound and well burnt, equal in size, straight and sharp in the arises and shall be obtained from the manufacturers approved by the Engineer.

Samples of the bricks are to be submitted to the Engineer for his approval and every consignment delivered to the works shall be equal in quality to the approved samples retained by the Engineer.

Bricks delivered to the Works shall be unloaded by hand and not tipped.

F3.2 Cement Mortar For Brickwork

Unless otherwise ordered cement mortar for brickwork shall consist of one part of Sulphate Resistant Cement to three parts of building sand by volume mixed with just sufficient water to make it workable.

Natural sand shall be used in cement- mortar for brickwork unless otherwise approved. The sand shall be obtained from source approved by the Engineer and shall comply with the requirements of B.S. 1200, "Building Sands from Natural Sources". When tested in accordance with B.S. 812 the grading; of the sand shall be within the limits given in Table I of B.S. 1200.

F3.3 Laying

Unless otherwise specified brickwork shall be laid in English Bond.

Bricks shall be laid true to line in level courses and to the dimensions shown on the Drawings. Immediately before being laid the bricks shall be thoroughly soaked in clean water and before continuing partly completed work the exposed bed joint shall be likewise soaked. The joints shall generally be not more than 6 mm in the beds and 10 mm at the ends or such other dimensions as may be agreed by the Engineer and the whole joint shall be completely filled with mortar.

Brickwork shall be carried up in a uniform manner and no one portion carried more than 1.0 meter above another, the ends being raked not toothed.

F3.4 Cavity Walls

Cavities of cavity walls shall be kept free from mortar droppings. Generally cavities shall be raked clean but where this is not practicable battens must be carried up to cover the cavity.

Wall ties shall be of the galvanized vertical twist type in accordance with B.S. 1243 and shall be built into the brickwork at the rate of three to every square meter.

F3.5 Pointing

Unless otherwise specified exposed Laces shall be raked out to a depth of 20 mm and pointed in 1 to 5 cement sand mortar as the work proceeds, care being taken to ensure a uniform color.

All joints in Laces not exposed shall be filled flush with mortar.

F3.6 Protection and Curing

The precautions to be observed in laying and protecting brickwork during hot or frosty weather and in curing finished work shall be as specified for concrete. The Contractor shall be responsible for any damage to the completed brickwork by others till the Completion of the Project.

F3.7 Brickwork Connections to Reinforced Concrete and Steel Structures

Connections of brickwork to Reinforced Concrete and steel Structures shall be cut carefully to ensure tightness. Anchorages properly secure in the brickwork.

F3.8 Installation of Doors, Gates, Windows, Metal Work

Doors, gates windows, metal work, etc shall be installed with the assistance of fitters and/or metal workers of the suppliers.

F3.9 Lintels and Span Members

Lintels and span members for openings shall be made of reinforced concrete or shall consist of precast reinforced concrete elements. If they are located within fair faced brick work, they shall be provided with appropriate face work Lintels. will be included in the brick work measurements.

F3.10 Expansion Joints

Expansion joints provided in structures shall be properly carried on in the adjacent brickwork. They shall be filled with resilient, non-aging and fire resistant jointing material and closed with a permanently elastic material and or cover strips.

F4 FLOORING

F4.1 Concrete Floor Finish

Concrete finishes, shall be applied on all concrete slabs whose surfaces will normally not receive any further treatment.

Before applying concrete finish to already hardened or cured concrete slabs, the surfaces shall thoroughly be cleaned from all rubbish, concrete and mortar droppings. Oil-and grease soiled parts shall be cleaned with oil-removing agents or equivalents.

For a good bond, surfaces shall be rough. The surface shall be washed thoroughly with pressure water and be kept wet for 24 hours prior to placing the concrete finish, but no free water shall remain on the surface during placing of concrete.

For floors, subject to normal wear, a crack-free, bonded concrete with a floated finish, shall be placed. The minimum thickness of the Concrete shall be 5-7 cm. Floated finish for offices and rest rooms shall have a minimum thickness of 5.5 cm, allowing for a compressibility of approx. 7-mm for the insulating layer.

Areas of 25 m² and above shall be subdivided by expansion joints. The spacing between joints shall not be larger than 6.00 m. If possible, the length/width ratio shall be 1:1, but not more than 1:1.5 expansion joints shall be continuous and shall not be wider than 15 mm.

Concrete finishes shall be carried out perfectly level or sloped towards floor drains or drainage ducts, according to drawings.

On thoroughly cleaned, roughened and wetted concrete surfaces a bonding course of pasty, rich cement mortar scrubbing shall be applied with a stiff brush prior to placing the bonded concrete.

Before the applied mortar has thickened appreciably, the top course shall be added, tamped or rolled and be leveled to the required size and slope. Tampers and/or rollers shall have sufficient weight to assure thorough compaction of the bonding concrete. Surfaces shall be smooth, have a dense finish, be free from defects and blemishes, floors shall be covered completely with clean, airtight, no water- absorbing coverings such as plastic sheets to prevent against a too-quick loss of moisture, especially in very dry climate. During curing time (maximum 2 weeks), no usage shall be made of the floor.

Bonded concrete surfaces which shall be topped with any kind of material to be set in cement mortar, shall be left with a rough surface, whereas surfaces to receive toppings with PVC tile work, linoleum or rubber to be glued to the bonded concrete with a bituminous mastic, shall get a floated finish, perfectly smooth and level.

Edges along expansion joints in wearing concretes shall be protected with a metal flashing (flat or angle steel). The interspace shall be filled with durable joint sealing-tape.

Wearing areas with concrete finish bigger than 25 m² shall be subdivided by joints into units corresponding to the room layout.

F4.2 Terrazzo (Mosaic) Tiles

Terrazzo (commonly known as mosaic) tiles shall be first grade tile of the mechanically compressed type, tiles shall be as indicated on drawings, well shaped with straight edge perfectly flat, free from defects which affect appearance or serviceability. The upper 7 mm shall consist of a mixture of approved marble chunks and colored cement at a ratio of 650 kg per cubic meter of chunks. The lower part shall be a mixture of cement and sand.

F5 GLAZED WALL TILING (CERAMIC TILES)

Where specified on the drawings or ordered by the engineer glazed wall tiling shall be glazed earthenware complying with the current B.S. and shall be of a uniform size. They should be homogenous, flawless, sharp edges, and free from cracks. The upper surface and sides shall be perfectly straight and flat.

The tile shall be backed first with a coat of 1:3 cement mortar (to act as a foundation coat) not less than 6 mm in thickness. The first coat shall be scratched or deeply scored. A second layer shall be set by trowelling on the first coat or to the back of tiles; and immediately the tiles shall be floated.

Joints shall be straight, level, perpendicular and of even width not exceeding 1.5 mm. Vertical joints shall be maintained plumb for entire height. All joints shall be grouted with 1:1 sand cement mortar using white cement.

The tenderers shall include for all necessary core tiles, angle heads, internal heads, etc. Only first quality glazed tiles shall be employed.

F6 ROOFING

The following procedures must be followed for all roofs to be heat insulated and water proofed.

- (1) Concrete slab surfaces must be repaired, cleaned, made free from loose materials, pockets, etc.
- (2) The surface under waterproofing membrane shall be primed with approved asphalt primer.
- (3) Waterproofing membrane of two layer of three ply roofing felt.
- (4) Setting bed of 3cm thick dry clean river sand shall be laid over the water proofing membrane and under the insulation layer.
- (5) Roof insulation of polystyrene elements lay over the clean river sand layer with a minimum thickness of 5 cm.
- (6) Precast concrete elements (slabs, skirting, corners) are to be laid floating on the earth bed. All elements will have a special edge profile so that, when laid, they form between each other or with the parapet wall (at skirting a joint of about 2x2cm the slabs to be laid probably so that the resulting joints will be equal and in a straight lines that will divide the roof into a regular checker work. The surface of the slabs will be smooth cement finish. The joint must be perfectly dry, all dust and loose particles to be removed. The surface of the joint should receive a preliminary impregnation of a special primer applied with a thin brush.
- (7) After drying, the joint shall be filled with special hot appropriate tools.

Specifications of Concrete Elements: The Concrete elements (Slabs, Skirting, and Corners) are to be precast with special care. Water proofing compound should be added to the concrete mix. All those elements should be absolutely watertight.

- (1) The Precast concrete slabs should be of a size 80x80x4 cm.
- (2) The proportion of cement to aggregate is to be 1:3 Aggregate size will be ($\frac{1}{2}$ " (12mm) and the specification of materials used in structural concrete.
- (3) The slabs should be with sharp edges right angle, free from cracks and the difference of its horizontal distances should not be more than 3 mm for its thickness.
- (4) When drying the slab at a temperature of 37^o C and emerging it in water for 48 hours and weighted then the increase in weight should not be more than 1.5% of its weight when dry.
- (5) The required load to break the slab should not be less than 700 kg when loading gradually at a speed of not more than 10 kg/sec, loads are acting along the middle line of the slab of 5 cm thick and the slab is supported on points in the direction of the line of loading and the distance between points of supports is 45 cm.
- (6) The concrete elements should be taken from moulds before having 70% of required strength of concrete.

F7 DOORS

F7.1 General

Dimensions and details of doors shall be in accordance with the drawings.

Shop drawing or doors, including the method of hanging doors on frames, shall be

submitted for the written approval of the Engineer before beginning of fabrication.

The hardware shall be of best quality and all locks will be arranged under a master and sub-master keyed system.

F7.2 Steel Doors

All steel doors and frames shall be made of mild steel welded without deposition of metals and properly reinforced. Corners shall be of welded construction with all joints in face welded and ground smooth. Welds must develop the full strength of the section and all joints in face to occur over reinforcing members.

After assembly, all metal shall be thoroughly cleaned of rust, oil and grease and given a coat of an approved rust resisting metallic primer with filler as required. Doors and frames shall be painted, the colors of which shall be according to the instruction of the Engineer.

F7.2.1 Sliding-Folding Steel Doors

Doors shall be double or single sliding or sliding-folding type, as specified, and shall consist of mild steel plates welded to mild steel angle iron or channels framing and bracing.

The leaves of sliding and sliding-folding doors shall be hung from wheel ball bearing hangers operating in overhead corrosion resisting box type track of adequate size fixed by brackets to the lintels. The doors shall also be provided with corrosion resisting floor channel and guide, stops, handles, hasp and staple, and bolts for fastening doors under this item shall be fitted with a tower bolt on one side and locking arrangement on the other, and push and pull handles.

Doors when required shall be equipped with small hinged pass doors for use by pedestrian.

Weather proof and dust proof doors where specified shall be fitted with weathering fabric inserted at the sides, top and bottom. Weathering shall be carried around at leading edge to act as wiper.

F7.2.2 Steel Hinged Doors (double-leaf)

All double-leaf hinged doors shall be double plated, consisting of 1.5 mm mild steel sheets welded to iron framing and shall be braced.

The frames shall be of a suitable section to provide sufficient rigidity. The hinges shall be operated on bush bearing and shall be strong and durable. The door shall be fitted with best quality flush type and shall have locking arrangement of the best quality from outside. Lock set shall be with dead bolt operated from outside by key, inside by thumb turn and it shall be provided with fixed knobs or lever handles on both sides (as specified).

F7.2.3 Steel Hinged Doors (Single Leaf)

The specification of this type of door shall be similar to the double-leaf hinged doors above except that no tower bolts, only one door check (closer), and one handle on each side shall be required.

F7.2.4 Steel Hinged Doors (triple-leaf-steel and glass)

The dimensions of the door shall be generally according to the Drawings. Specification of steel sheets, framing and hardware shall be similar to the double-leaf, hinged doors

mentioned above.

F7.3 Wooden Doors

All wooden doors shall be flat, smooth-faced and shall be fixed properly in position. Each door shall be fitted with best hinges, handle and locking arrangements.

F7.3.1 Teak Doors

Teak doors shall be made out of selected well seasoned teak planks not less than 5 cm finished thickness and according to the drawings. Teak doors shall be sand-prepared and twice oiled and shall be finished in wax. Frames shall be solid out of 15 cmx60 cm, rebated, and once chamfered, unless otherwise stated on drawings or in Bills of Quantities.

F7.3.2 Oak Wood Doors

Plywood doors shall be made of oak wood with solid core flush faced in plywood; finished thickness shall not be less than 4 cm. Frames shall be solid cut of 12 cm x 5 cm hardwood. The doors and frames shall be painted with two coats of oil paint according to the instructions of the Engineer.

F7.4. Aluminum Doors

Frames shall be formed from rolled, strips or extruded aluminum and be at least 2mm thick. Fastenings, bolts and screws shall be made from hardened aluminum, stainless steel or other non-corrosive metal.

F8 WINDOWS

F8.1 Steel Windows

Dimensions and details of steel windows shall be in accordance with the drawings.

All windows shall be constructed of mild steel section of such dimensions as to ensure proper rigidity and welded without deposition of metals and properly reinforced. Corners shall be of welded construction with all joints face welded and ground smooth, welds must develop the full strength of the section. All open-able panels should be supplied with fully prevent the entry of insects. After assembly all metallic primer with filler as required, and shall receive two coats of oil paints, the color of which shall be according to the instructions of the Engineer.

F8.2 Aluminum Windows

Frames shall be formed from rolled, strips or extruded aluminum and be at least 2mm thick. Fastenings, bolts and screws shall be made from hardened aluminum, stainless steel or other non-corrosive metal. Windows shall be of heavy-duty extruded aluminum construction. Windows shall be operable where scheduled. Window finish shall be anodized aluminum.

F8.3 Glazing

All glass sheets for windows and/ or doors shall be 6 mm thick unless otherwise stated on drawings or in the Bills of Quantities. Any glass chipped, cracked, scratched, broken or permanently stained, itched, or damaged in any way prior to the acceptance of the building shall be replaced at no additional cost. Putty shall be of the tropical type specially prepared for use with metal window and/or doors and of a make approved by

the Engineer.

F9 PLASTER WORK

F9.1 General

The works included in these specifications cover the complete supply, temporary storage and sheltering of all materials and the execution of the plastering work, its protection and final cleaning up.

All brickwork and, where necessary and indicated, concrete walls and ceilings shall be coated with plaster. Plaster work shall be carried out considering climatic particularities.

F9.2 Plastering Materials

(1) Cement Rendering

(a) Surface Preparation

Surface to be rendered shall be free from grease and shall be thoroughly cleaned with wire brush soaked in water. Surfaces of reinforced concrete columns and beams shall be chipped and humidified to increase adhesion of the cement coating.

(b) Materials

The coats of rendering shall be composed of cement and sand mix in the ratio 1:3. An addition of 5Kg. of hydrated lime may be added per 50 Kg. of cement to make a more workable mix. The cement used shall be in according with the provisions of clause 122 of this specification.

The sand shall be hard, durable, clean and in accordance with the provision of clause 123 except that its grading shall be within the limits stated below:

B.S Sieve	Percentage by Weight	Passing B.S. Sieve
	First Coat	Finish Coat
3/16 " (4.8mm)	100	100
No. 7	90-100	90-100
No. 17	70-100	90-100
No.25	40-80	55-100
No. 52	5-40	5-50
No. 100	0-10	0-10

The above grading of sand for the finished coat may be modified to suit certain texture finishes.

(c) Application:

Two coats of cement rendering shall be applied. The first coat shall be applied to the clean, wet surface by means of a trowel, and be slightly

combed with a wire or wooden scratcher. It shall be kept moist with a fog spray for two days, and then be allowed to dry out.

The finished coat shall not be applied until the first coat has been seasoned for about 3 days. Just before the application of the finish coat the first coat shall again be wetted with fog spray. Where cement plasters with a smooth trowelled finish is specified or indicated on the drawing, the finished coat shall first be floated to a true and even surface then trowelled in manner that will force the sand particles down into the plaster, with a final trowelling to leave the surface burnished smooth and free from rough areas, trowel works, checks and other blemishes. In all other cases where a smooth finish is not specified, the finished coat shall be flouted to true and even surface with a uniform texture.

The finished coats shall be kept moist with a fog spray for a least 2 days, and thereafter shall be protected against drying until it has properly and thoroughly cured. The total thickness of rendering shall be not less than 1.5 cm.

All adjacent of the finished work which could be stained or damaged shall be adequately masked.

(2) Cement Lime Plaster

(a) Surface Preparation

All surfaces to be plastered shall be free from grease and loose material and shall be thoroughly cleaned with wire brush soaked in water. Surface of reinforced concrete columns and beams shall be chipped and humidified to increase adhesion of the cement coating.

(b) Materials

The cement and sand shall conform to the description specified in sub-clause 148 (a).

The lime shall be of properly burned calcium carbonate, which shall be stored upon arrival at the site in dry sheds with raised floors and waterproof walls and roofs.

Any lime damaged as a result of exposure to moisture before or during storage will be rejected. The hydrated lime shall conform with B.S.S. No. 890.

(c) Application

A preparatory coating of 1:1 sand cement slurry shall first be applied to the clean wet surface by vigorous brushing and immediately stippling with a banister brush or similar to a close texture key. This preparatory coat shall be allowed to harden thoroughly for about 3 days, depending on water conditions.

Plastering shall then be carried out in three coat work, with mortar of 1 volume of cement 2 volumes of hydrated lime, 8 volumes of sand.

The first coat shall be about 8 mm. thick and shall be so applied as to maintain maximum adhesion and coverage. It shall then be combed with a wire brush or wooden scratcher to provide a key for the second coat. A minimum of 4 days interval shall be allowed before the application of the second coat.

The second coat shall be about 8 mm thick applied to obtain a plain surface with all internal angles plump and square. It shall be keyed as for the first coat and left for a minimum of 4 days before the application coat of the finish coat.

The finish coat shall be applied as thinly as possible with a thickness of about 5mm. and shall be brought to a smooth trowel finish and allowed to dry out to a uniform colour.

The total thickness of the finished plaster work shall be not less than 2 cm.

All cracks, blisters and other defects shall be out to a rectangular shape with edges undercut to form a key and shall be finished flush with faces of surrounding work.

The whole of the plaster work shall be brought to a smooth even surface.

(3) Gypsum Plaster

(a) Surface Preparation

Surfaces to be plastered shall be prepared as in sub-clause 148 (b).

(b) Materials

The cement and sand shall conform to the description in sub-clause 148(a).

The gypsum shall be pure calcium sulphate and supplied from an approved Mechanical Factory and shall be delivered to the site in sealed bags. All under burnt or over-burnt gypsum shall be rejected and the Contractor shall provide facilities for each batch of material to be checked and tested on the site to the satisfaction of the Engineer. The gypsum shall be kept in proper sheds on site exactly as described for lime in sub-clause 148(b).

(c) Application

A preparatory coat of 1:1 sand cement slurry shall be applied to the clean, wet surface by vigorous brushing and immediate stippling with a banister brush in order to form a close texture key.

Two coats of gypsum shall be applied. The first coat shall be applied evenly and with sufficient material and pressure to form a good bond with the underlying surface. The surface shall then be rodded and floated then roughened slightly with a stiff bristled brush.

The second coat of smooth white finish shall be applied by trowel as soon as the first coat is thoroughly dry, it shall be wetted evenly by brushing or spraying. As the finish coat sets and shrinks, it shall be thoroughly and uniformly packed and compressed by heavy scouring

with the trowel. The material shall be allowed to shrink between scouring operations, and additional water shall be brushed on as required. The scoring shall be continued until a smooth dense surface is obtained.

Total thickness of plaster should not be less than 2 cm.

F10 SPECIAL SPECIFICATIONS FOR FAIR-FACE BUILDING BRICK

F10.1 Fair-Face Building Brick (English Bond)

Clay building bricks used for fair-face bricks and in jack arching shall comply to Iraqi Standard (IQS 25/1988-Grade A) as follows:

- (1) The brick shape should be uniform. All the edges should be straight and with right-angle corners.
- (2) The brick dimensions shall be (240x115x75)mm.
- (3) The maximum allowance in the change in brick dimensions is as follows:

Maximum change in length or width = $\pm 3\%$

Maximum change in thickness = $\pm 4\%$

Maximum surface leveling = 5mm

- (4) The minimum compressive strength of the bricks is as follows:

For one brick =16 MPa

Average of 10 bricks = 18 Mpa

- (5) The maximum percent of water absorption is as follows:

For one brick =22%

Average of 10 bricks = 20%

- (6) The efflorescence of the bricks should be light.

F11 PAVING AND WALL FACINGS

F11.1 Sub-base

Ground under all paved areas shall be leveled and well compacted. A layer of clean, well wetted and uniform gravel and sands shall be used as a sub-base for all pavements and ground floors (unless otherwise specified). The thickness of the sub-base shall be unless otherwise specified at least 20cm after compaction.

Where tiling is to be used C 20 concrete shall be poured over the sub-base to a thickness of 10 cm. (unless otherwise specified). The surface of this concrete shall be level and shall be combed with a wire brush to receive the tiles.

Concrete Paving:

Where a concrete floor is specified, it shall be poured over a well wetted sub-base, in chessboard fashion. The square shall not exceed 5 meters in either direction (unless

otherwise specified or approved by the Engineer). Alternate panels shall be laid and the intermediate panels shall be poured at least two days later.

The concrete used for the paving shall be of C25 with S.R. cement unless otherwise indicated on drawings.

The concrete shall be well leveled or sloped according to specification and the upper surface smoothed.

Bitumen flexible joining materials, approved by the Engineer, shall be laid in accordance with the manufacturer's instructions. The concrete shall be properly cured.

When no finishing material is specified for the concrete floor slab, the top 2 cm of the floor slab must be made of cement screed, smoothly and surfaced and formed into pattern when required by the Engineer.

F11.2 Floor Tiles

(1) General

Floor, skirting and corner tiles shall flawless, sharp edge, and without cracks. The upper and side surface shall be perfectly flat, finely grained, and colours approved by the Engineer.

Well soaked tiles shall be laid with 1:3 cement mortar used to fix the tiles, and the well laid and leveled tiles shall be grouted with a 1:1 cement mortar. Joint width shall be kept to a minimum.

As soon as the tiles are laid they shall be protected with a 2 cm. thick layer of saw dust sand, which shall be removed upon complete, and the tiles shall be thoroughly cleaned.

Sand for setting floor beds and base coats for walls shall be well graded, passing No. 8 sieve with not more than 5% passing a 100-mesh screen. Sand for grouting shall be screened to pass a 30-mesh sieve with not more than 5% passing a 100-mesh screen.

(2) Ordinary Cement Tiles:

The cement tiles shall be of uniform size not less than 20x20x2cm thick. The upper 0.5 cm of the tiles shall consist of a minimize of fine sand and cement (the quantity of cement being at least 650 kgs. per cubic meter of sand) with a colouring material added.

The upper surface shall be homogenous and smooth and shall have a colour approved by the engineer. The lower part of the tiles shall be a mixture of cement and sand, the quantity of cement being at least 450 kgs. per cubic meter of sand.

(3) Terrazzo Tiles:

Terrazzo (commonly known as mosaic) tiles shall be first grade tile of size the mechanically compressed type. Tiles shall be 30 x 30 x 2.5 cm in size unless otherwise indicted on drawing, well shaped, with straight edges perfectly flat, free from defect, which affect straight appearance or serviceability. The upper 7 mm shall consist of a mixture of approved marble chunks and coloured cement at a ratio of 650 kgs. per cubic meter of meter chunks. The lower part

shall be a mixture of cement and sand; the quantity of cement being at least 450Kgs. per cubic meter of sand.

(4) Ceramic Tiles:

Where specified on the drawing or ordered by the Engineer ceramic tiles will be glazed earthenware complying with the current B.S.S. (or approved equal) and shall be of uniform size. They shall be homogenous, flawless, sharp edges, and free from cracks. The upper surface and sides shall be perfectly straight and flat.

The tiles shall be backed first with a coat of 1:3 cement mortar (to act as a foundation coat) not less than 6 mm in thickness. The first coat shall be scratched or deeply scored. A second layer shall be set by trowelling on the first coat or to the back of tiles; and immediately the tiles shall be floated.

Joints shall be straight, level, perpendicular and of even width not exceeding 1.5mm. vertical joints shall be maintained plump for the entire height. All joint shall be grouted with a 1:1 sand cement mortar using white cement.

The tenderers shall include for all necessary core tiles, angle heads, internal heads, etc. only first quality glazed tiles shall be employed.

(5) PVC Tiles:

The floor screed shall be finished with a trowel and shall be free from all trowel marks, laitance, dust and surface moisture.

The tiles shall be homogenous, flawless, sharp edges, and free from cracks.

F12 RESERVED

F13 GENERAL INSTRUCTIONS FOR PLUMBING WORKS

- (1) The sanitary works specified here after and covered by this part of the specifications shall comprise of installing, testing and commissioning of all plumbing fixtures, treatment, distribution of water supply and disposal of sewage and drainage, related to the building project.
- (2) The plumbing work in the building project shall mainly consist of service and distribution pipes for water supply, plumbing fixtures, soil, waste and vent piping, building drains and sewers including their respective connections, devices and appurtenances within the property lines of the permission.
- (3) The water supply system shall consist of further treatment of city water supply as specified, for the particular temperature, pressure and purity and further distribution within the premises.
- (4) The sewerage shall consist of collection of all soil and waste from the premises and effecting such treatment that the discharge can be disposed off suitably so as not to be objectionable as per the prevailing codes of health and sanitation.

- (5) The storm drainage shall be suitably laid away to the nearest public disposal system.
- (6) The scope of work will be itemized broadly as below and shall consist of the following major items:
 - (a) Water supply main & distribution.
 - (b) Water storage pumping.
 - (c) Hydro pneumatic system.
 - (d) Hot and cold water distribution piping with necessary control.
 - (e) All plumbing fixtures.
 - (f) Sanitary, soil, waste and vent piping.
 - (g) Storm and building drainage.
 - (h) Sewage system and disposal.

The work shall include provision of all labor and materials complete in installing, operating and maintaining the plumbing, water supply and the drainage systems and allow for all transportation, tools and plant, scaffolding and relevant temporary works for the lay-out execution and finishing of the works.

Fire protection system comprising of:

- (a) External fire hydrants
 - (b) Internal hose reel
 - (c) Portable extinguishers.
 - (d) Raw water system.
- (7) These specifications are a brief outline and description of the work include, but shall not be considered as complete and inclusive.
- (8) The General conditions of contract, Bill of quantities, drawings and the following technical specifications etc, are complementary to each other and shall be read in conjunction with each other.
- (9) In case of any interpretation between the specifications, General conditions etc. the specifications in the bill of quantities shall override all other provisions.

The relevant British Standards, or other equivalent, shall be applicable in case the exact nomenclature or specification of item of work is not mentioned in the documents.

- (10) All materials shall be new and the best of their respective kinds, and shall be suitable for the conditions and duties imposed upon them in actual use. These shall be the products of reputable manufacturers and shall have the approval of the Engineer, before being incorporated in the works.
- (11) It is to be clearly understood that the materials or appliances provided shall comply with all the requirements of the local authority and shall be provided in all cases with the necessary auxiliary or incidental fittings and electrical controls as specified to make the system complete as a whole.
- (12) All small builders work in connection with the installations, fixtures, supports, etc. shall be included in the quoted rates.
- (13) Minor details not usually shown or specified but necessary for the proper installation and operation, shall be included in the work, as if the same has been specified or shown.

F14 MAIN, DISTRIBUTION AND SERVICE PIPES

F14.1 General

- (1) The main and distribution pipes for water supply and fire protection of ductile iron and shall be laying in carefully preferred excavated trenches so that the barrels of the pipes when laid are well bedded down for their whole length on a firm surface and are true to line and gradient, generally at a depth of 1 m or as specified.
- (2) The width of the excavation shall be sufficient to allow the pipes to be properly laid and jointed, joint holes being made where necessary.
- (3) Before laying each pipe and fitting should be thoroughly cleansed internally and the ends temporarily plugged.
- (4) Precaution shall be taking to prevent floatation of the pipes, should the trench become flooded.
- (5) The coating, sheathing or wrapping of the pipes shall be examining for damage and repaired where necessary.
- (6) The laying of pipes shall preferably proceed in an “uphill” direction to facilitate joint making.
- (7) Thrust blocks of concrete shall be forming at all bends, branches and dead ends to transmit the hydraulic thrust on to undisturbed ground and spread it over a sufficient area, as per the following table (when specified).
- (8) End thrust and radial thrust on bonds in Mains (calculated for a pressure of 100 lb/in²).

F14.2 Building Drainage

- (1) Soil, waste and vent stacks shall be providing installed with extensions and branches to all plumbing fixtures as shown on the drawings.
- (2) Soil and waste piping and other drainage piping underground shall be u.p.v.c. Ventilation systems inside the building shall be u.p.v.c, exposed pipes shall be galvanized steel pipes. Pipes shall have bitumen coating inside and outside in both cases.
- (3) The rainwater pipes shall be cast iron to B.S 460.
- (4) Buried piping shall be supported throughout its entire, length, to the grades as shown.

If installed on fill, the pipes shall be supporting by concrete cradles to firm earth or a continuous bed of concrete as specified.

- (5) All excavations required to be made for the installation of the building drainage system or any part there of within the walls of a building shall be open trench work and shall be kept open until the piping has been inspected, tested and accepted.
- (6) Adequate precaution shall be taking to ensure proper compactness of backfill around piping without damage to such piping. Trenches shall be back filled in thin layers to (300 mm) above the top of the piping with clean earth which shall not contain stones, boulders, cinder fill or other materials which would damage or break the piping or cause corrosive action. The fill shall be properly compacted.
- (7) When excavating a trench, sufficient compacted soil should remain at the bottom so that the pipe, both joints and barrel, rest on and is fully supported by undisturbed earth.
- (8) A soil or waste pipe or building drain passing under foundation wall shall be provided with a relieving arch, or there shall be built into the brick wall an iron pipe sleeve two pipes greater than the pipe passing through, or equivalent protection shall be provided as may be approved by the Engineer. Annular space between sleeves and pipes shall be filling or tightly caulked with coal tar, or asphalted compound, lead or other materials found equally effective.
- (9) No piping shall be laying parallel to footings or outside bearing walls closer than (1 M) except as may be approved by the Engineer upon finding that a leisure distance is safe.
- (10) Piping installed deeper than footing or bearing walls shall be 45° except as may be approved by the Engineer upon finding that a greater angle is safe.
- (11) Drainage and Vent Pipes:
 - (a) Drainage and vent pipes shall be installing in as direct and straight as possible without drops or sags. The pipes shall be graded and joined to drain to the outlet by gravity at the following minimum slopes.
 - (b) Horizontal piping 100 mm □ with a slope of 2 %.
 - (c) Horizontal piping greater than 100 mm □ within a slope of 1 %.

- (d) Connections to soil and waste stacks shall be made by the appropriate use of 45° long quarter bends, sixth, eighth or sixteenth bends, or by combination of these fittings. Standard tees, quarter bends crosses shall not be used on drainage pipes. Such fittings may however be used on vent pipes and on other piping conveying fluids that not carry clogging, substances. No fitting having a hub in the direction opposite to flow or the branch shall be used as drainage fitting. No drainage or vent piping shall be drilled or tapped. W.C. branch to the stack shall preferably be made below the branch to lavatory basins, sinks baths etc. waste branches must not enter the stack opposite a W.C. branch as there is then the risk of W.C. discharge entering waste branch. In this case, the connection should be at right angles.
- (12) Connection between a vent pipe and a vent stack or stack vent shall be at least 150 mm above the rim of the highest fixture served by the vent. Horizontal vent pipes forming branch vents or loop vents shall be at least 150 mm above the floor level rim of the highest fixture served. All vent and branch vent pipes shall be so graded and connected as to drip back to the soil or waste pipe by gravity.
- (13) All vent pipes extending through the roof shall pass through flashing sleeves properly water proofed, in an approved and neat manner. The vent pipes must be extending at least 0.6 m above the roof and shall be at least 1.5 m above the roof, when the roof is accessible to the residents. Its top shall be covered with a durable and strong metal screen or of wire balloon to exclude dropping of objects down the pipes.
- (14) The drainage, soil and waste pipes shall be u.p.v.c.
- (15) All pipes work shall be so arranged as to be accessible for repair and replacement without disturbing adjacent work. Suitable access doors and frames shall be provided wherever valves, controls and other apparatus requiring periodic inspection or maintenance to be located in enclosed spaces, behind partitions or in the spaces above suspended ceiling or in the pipe shafts.

F14.3 Piping

- (1) Drawings are generally diagrammatic and indicative of work to be installed. Run and arrangement of piping shall be approximately as indicated, subject to modifications as required to suit conditions in building to avoid interference with work of other trades, or for proper, convenient and accessible location of all parts of piping system. Due to small scale of drawings all required offsets, fittings, valves, traps, drains etc, may not be indicated. The architectural, structural, electrical and mechanical drawings and details may be referred to carefully and checked, noting location of pipe shafts and conflicts with work of other trades and the work shall be arranged accordingly furnishing all offsets, fittings, valves traps, drains etc. required to meet such conditions.
- (2) The piping shall be running in wall chases, recesses, pipe shafts and false ceilings where the same are provided. Exterior utilities are diagrammatic and exact location and invert elevations shall be as indicated or required to meet existing conditions. The piping shall not be closed or covered before examination and testing. The piping shall be run straight and direct as possible, in general forming right angles with or parallel with walls or other piping and neatly with risers erected plumb and true. The piping shall be hanging at or in

ceiling from construction above, as close as possible to bottom of slabs, beams etc. maintaining max. head room at all time in a neat manner on approved type of hangers.

- (3) The architectural drawings may be checking with for approved ceiling heights and work shall be installing above this height. Control valves shall be providing as shown or required for complete regulating control of all system, plumbing fixtures and equipment. All valves shall be accessible and these shall not be installing with handles pointing down.
- (4) Adequate provision for proper expansion and contraction of piping shall be made. For piping passing through building expansion joints.
- (5) In concrete construction, approved inserts shall be carefully set to support the piping, close to the bottom of beams, slabs etc. The pipes passing through floors shall pass through a galvanized sheet iron tube not less than one size larger than the pipe or its covering. Escutcheons shall be of spun brass made of 12 gauge sheet and shall be chromium plated for installation in finished spaces. These may be of cast iron in other locations.
- (6) The spacing of hangers and supports for different type or pipes shall be as follows generally.

Type of pipe	Vertical	Horizontally
Cast iron soil pipe	at every story height and at its base	at not more than 1.5 m intervals
Socket pipe	at not less than every other story height	at approximately 3.5 m interval depending on dia. of pipe (Table below)

Spacing of mixing for internal piping

Material of pipe	Size of pipe (mm)	Max-Spacing of vertical run	Supports in a horizontal run
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<i>Galvanized mild steel</i>	15	2.4	1.8
	20	3.0	2.4
	25	3.0	2.4
	32	3.6	2.7
	40	3.6	3.0
	50	3.6	3.0
	65	4.5	3.6
	80	4.5	3.6
	100	4.5	3.9
	150	5.2	4.5
<i>Cast Iron, and p.v.c.</i>	50	1.8	1.8
	80	2.7	2.7
	100	2.7	2.7
	150	3.6	3.6

F14.4 Jointing

- (1) Joints and connections in the plumbing system shall be gas tight and water tight for the test pressures as specified No varnish or other coatings are permitted on the joint until after the joint has been tested and approved.
- (2) Joints in cast iron with spigot and socket pipes shall be mechanical coupling type. Flexible joints in which preformed joint rings of rubber or other material are compressed between the spigot and socket may also be used with the approval of the Engineer.
- (3) Screwed steel piping shall be jointing with screwed socket joints using fittings of wrought iron, steel, or malleable cast iron. A jointing compound or tape may be using with a few stands of fine hemp where necessary. Compounds containing red lead shall not be used due to the danger of contamination of the ware. Care should be taking to remove any burr from the ends of pipes and to prevent the entry of the excess jointing material.
- (4) Small diameter pvc pipes shall be jointed by using special jointing solvents provided by the manufacturer or alternatively with separate sleeves or with flexible rings and spigot and socket joints
- (5) Copper piping of small diameter shall be jointing to cast iron, spun iron or steel piping by the use of copper alloy unions.
- (6) For large diameters, the joints shall be made by flanged connecting pieces.
- (7) Small diameter plastic pipes may be jointing to metal piping by means of union adaptors for PVC pipes of 75 mm bore and upwards, flexible joints or flange joints may be used.
- (8) While jointing pipes to cisterns, care should be taking so that holes in the correct positions are made for the connection of pipes to cisterns. The end of the galvanized steel connecting pipe shall be threading,

passed through hole in the cistern and secured back nuts and washers both inside and outside.

F14.5 Test

- (1) All piping forming part of the domestic water system shall be tested before backfilled, covered up or built in to twice the hydrostatic working pressure.
- (2) The entire system of soil, waste and vent pipes and horizontal drains including all branches shall be testing either in their entirety or in sections. Each section shall be filling with water standing 3.3 m above the section (except the top most section) for at least 15 minutes at which condition, the pipes and joint shall show no leaks.

F15 HOT WATER SERVICES

- (1) The hot water services shall be by the installation of a number of domestic, electrically heated storage tank type heaters wall or floor mounted, with thermostatic control and piping to the fixtures as specified. The installation shall be complete with all necessary main riser branches and valves. Insulation shall be continuous throughout sleeves partitions and floors, as specified.
- (2) The installation of piping and thermal insulation shall generally be conforming to CP: 342.
- (3) The pipe work shall run in as straight and direct as possible with necessary claps and supports as generally described under paperwork.
- (4) Expansion joints in the hot water and hot water circulation risers and mains where the length exceeds 20 m or as specified or shown on drawings shall be providing.
- (5) Tees used must be of long sweep pattern except where non-circulating branches are taken off a circulation main, in which case square tees may be used.
- (6) Elbow should not be using as fittings except in non – circulatory branches and in other cases, bends are to be used.
- (7) Gradients on all pipe runs for both primary and secondary circulations should not be less than 1 in 240 for drainage.
- (8) There should be 20 mm minimum clearance between the surface of pipe and the finished surface of wall, partition or ceiling and 75 mm clearance between the surface of insulated or non insulated pipe and the finished surface of floor.
- (9) The following interval should be maintaining for pipe fixing and supports.

Size of pipe (mm)	Interval to vertical runs (m)	Interval to horizontal runs (m)
15	2.5	1.8
20	3.0	2.4
25	3.0	2.4
32	3.0	2.7

40	3.6	3.0
50	3.6	3.0
65	4.5	3.6
76	4.5	3.6
100	4.5	3.9

F16 ROOF DRAINAGE

- (1) Roof drainage shall be providing by fixing adequate number of roof outlets of cast iron conforming to BS: 452 painted with brass lock bolts and nuts, and complete with domed/flat gratings.
- (2) The vertical down pipes shall be circular cast iron rain water pipes to BS: 460, or equivalent.
- (3) The pipes shall be fixing in slope or vertically with necessary hangers and brackets of mild steel.
- (4) The down pipes shall be laid complete with offsets, if necessary and shoes or/and bends to the nearest storm water manhole or gully.

F17 STORM DRAINAGE

- (1) The storm water from roofs, paved yards, approaches the chambers and gullies to manholes.
- (2) The storm manholes shall be similar in construction in roads is drained through gully chambers and curb gullies to manholes.
- (3) The manholes shall be complete with manhole covers and frames of solid cover or with grating suitable for the particular duty as specified.

F18 SANITARY APPLIANCES

- (1) All sanitary appliances shall be new of approved quality, color and of standard design as specified. The fixtures shall be of twice fired, vitreous china ware of the specified color, having smooth, permanently non absorbent surface and free from pores generally conforming to BS: 3402.
- (2) Each fixture shall be complete with trap, waste, water connection and vent of sizes shown on the drawings or as specified. All exposed metal parts of the appliances shall be chromium plated, unless otherwise specified.
- (3) The appliances shall be adequately supporting independent of piping or other plumbing work.
- (4) All fixing screws should be of non-ferrous metal or stainless steel and any steel work in brackets or other supports should be galvanized, whether subsequently painted or not.
- (5) Brackets shall be of adequate strength and securely fixed with built-in-legs or of surface type securely screwed thereto. The screws should be driving into proper plugs inserted into holes. When brackets are fixing to thin or lightweight

partition walls, more secure fixing shall be provided by use of such devices as toggle bolts.

- (6) Appliances like W.C. pans fixed directly to the floor shall rest properly leveled and even surface. Appliances on pedestals or legs shall also be fastening to walls to give stability, except in those where the whole fitting is design to be self-supporting.
- (7) Water supplies and discharge pipes shall be installed before the appliances are fixed and the joints between appliances and traps and/ or pipes should be of union or detachable type.
- (8) Sinks and baths should be so fitting so that they drain to the outlet.

F19 EXTERNAL SEWERAGE

- (1) The external drainage pipes shall be U.P.V.C. pipes with necessary fittings complying BS: 4660.
- (2) The excavation for trenches of sewer pipes shall be to the correct depths and gradients and true to line.
- (3) The excavated material shall not be depositing within 0.5m of the edge of the trench and the sides of the excavation shall be supporting by planking or strutting as directed by the Engineer. The bottom shall be keeping free from water by pumping, bailing or otherwise. Excavation below required level shall be back filling at contractor's expense with 1:4:8 concrete as directed by the Engineer. Sufficient protective measures as lighting, warning signs etc. shall be taking conforming to the local byelaws and as directed by the Engineer.
- (4) The sewer pipes shall be laying on a granular material bedding 20 cm thick under the pipe in the bottom of the trench No. point bearing shall be allowing. U.P.V.C. pipes shall be laid and jointed as per manufacturers site instructions. After laying and pointing the pipes granular material same as in the bedding shall be placed on the sides of the pipe and trench shall be filled to a depth of not less than 30 cm above top of the pipe. The remaining trench shall be back filling with selected excavated material.
- (5) The pipes shall be jointed together with rubber rings or equivalent joint as per manufacturers instructions.
- (6) The manholes shall be constructing in brickwork as per the specified dimensions. The concrete base shall be at least 150 mm thick trench pipes shall discharge into the main stream as nearly as possible in the direction of flow in the main channel. In wet ground the outside faces shall be plastered in 1 : 2 cement mortar up to 300 mm above wet soil line with the addition of suitable water proofing compound as directed by the Engineer.
- (7) Where the depth of manholes exceeds 1.8 m brick on edge ring arches over the ends of the drainpipes exceeding 150 mm in diameter shall be built into the walls.
- (8) The manhole covers and frames shall be of medium duty and shall be bedding cement mortar 1:3 cement concrete 1:2:1 finished smooth on top and with other edges slightly roundel.

- (9) Where the difference in level between the branch pipe entering a manhole and the manhole invert exceeds 700 mm, the connection shall be made by means of cast iron vertical drop pipe encased in concrete 1:3:6 outside the manhole complete with tend junction.
- (10) The manhole covers shall conform to BS:497 or equivalent of medium duty for manhole located in areas where light vertical traffic is expected of heavy duty where heavy traffic load is expected and of light duty in foot paths and in areas of pedestrian traffic only.
- (11) The step irons for manholes shall be of galvanized malleable cast iron complying with the requirements of BS: 1247. Step iron should be built into the wall at every fourth course at 300 mm intervals, staggered both horizontally and vertically. The top step iron should be 450 mm below the top of the manhole cover and the lowest not more than 300 mm above the benching.

F20 FIRE PROTECTION

- (1) The fire protective measures for the building shall comprise of (1) providing portable fire extinguishers (2) hydraulic hose reels with packaged pump sets.
- (2) The lay-out as specified, workmanship and materials of pipes and fittings shall conform to the National fire protection standards and/or the relevant BS: codes of practice CP: 402 and its parts, or other equivalent.
- (3) Portable fire extinguishers of the specified type and weight shall be sited as directed by the Engineer in prominent positions on exit routes in such a way that no person need travel more than 30 m.
- (4) The extinguishers shall be supporting, the handles are 1.00 m above floor level, and shall be fixed in similar positions on each floor.
- (5) All similar extinguishers in building shall be of the same method of operation.
- (6) Extinguishers for special purposes such as in kitchen plant rooms etc shall not be fixed too close to the equipment where the fire risk is expected but at the exit from such a room.
- (7) The extinguishers shall not be placed, behind doors, in cupboards or deep recesses where they might cause obstruction to exit routes or be damaged by trolleys.
- (8) The hydraulic hose reels shall be sited in a prominent position at each floor level on exit routes preferably in corridors in such a way that the hose can be taken into every room and within 6.1 m of each part of the room, having regard for any obstruction.
- (9) The piping as specified or shown on the drawings shall be completing a neat with necessary clamps and supports. The piping shall be interconnecting and providing with valves to permit desired flexibility in control. The valves shall be of the outside screw and yoke pattern and shall be prominently located and conspicuously labeled.
- (10) The hose shall be of red rubber 19 mm/25mm smooth hose or of the specified size with a working pressure of (50 lbs /sq. in) and of the specified length from 18.30 - 36.60 m terminating in 6.4 mm nozzles as specified.
- (11) Each reel shall be connected by a short 25 mm □ branch pipe.
- (12) The hose reel and cabinets should be fixed so that the centre is between 765 mm and 1370 mm above floor levels.

- (13) At each floor at the hose reel connection, an automatic recessed swinging hose reel cabinet with door supporting bracket for installation, of adequate dimensions to enclose the hose reel shall be provided. A laminated plastic instruction plate shall be supplied with each reel.
- (14) An adjustable type pressure reducer shall be provided between the hose and standpipe to protect the hose against excessive pressure beyond 50 psi.
- (15) Approved expansion joints shall be provided where necessary.
- (16) The installation of the system shall closely follow the construction of the building to provide protection during the construction period.
- (17) The contractor shall furnish the complete details with sectional drawing of fixing the cabinet etc. The installation shall be tested and proved tight to a hydrostatic pressure at least 25 % in excess of the highest normal working pressure to which the piping will be subjected.
- (18) The dry riser/wet riser of the specified size shall be installed as shown on the drawings. In buildings with topmost story not more than 61m rising main shall be dry, in higher buildings the riser shall be wet and serve all stories above the first.
- (19) Instantaneous female outlets conforming to BS: 336 should be provided off the rising main on each story above the first, as shown on drawings. It shall be enclosed in a glazed cupboard clearly marked "FIRE BRIGADE WET/DRY HYDRANT".
- (20) The dry rising main shall be provided with two instantaneous male inlets conforming to BS: 336 (Fire hose couplings and ancillary equipment) for fire brigade connections. The inlets should be sited at a convenient position on the external wall of the building above 760 mm above G. L.
- (21) Positions for inlets should under all circumstances be electrically earthed and be contained in a glass fronted box, complying with BS: 3980.
- (22) The wet rising mains shall be provided with adequate water storage and automatic pumps as specified, and where provided, as per the relevant standards.

F21 PRESSED STEEL TANKS

The pressed steel tank shall consist of pressed steel of modular dimensions, galvanized according to B. S. 1564. All plates shall be of 6 mm thickness except the cover, which may be of 3.17 mm thickness. The tank shall be internally divided into several compartments when required. The tank plates shall be of external flange construction and bolting shall be done with suitable gasket materials. All necessary piping connections shall be provided and welded at the manufacturing firm. The tanks shall be provided with concrete dwarf wall supports.

The walls should have a minimum 150 mm to 225 mm width and tapered at the top to not more than 110 mm width and shall have a height of 400 mm and provided under each joint. They should extend a minimum of 300 mm beyond the tanks width or length.

When the tank is installed inside, the cover shall be of weather proof type supported on angle bearers. The tank shall be of reinforced corner plates and each compartment shall be stayed with angle section stays welded to cleats.

The tank shall also consist of brass ball valves with floats of size and number required, with incoming rising main as shown on the drawing. The tank shall have 100 mm

ventilator 600 mm manhole and inside step irons if the tanks depth exceeds 1.2 m with hinged scaled lid for the cover.

The tank shall also be fitted with overflow pipe, scour pipe with valve water level indicator etc. Jointing strip shall be provided for all joints so as to make the covers weather and vermin proofs For roof tanks electric float switches shall be provided to transfer pump switching on and off as per the level in the roof tank. The contractor shall undertake the entire wire connection to float switches and pump starter.

The contractor shall submit full details of these works and materials and obtain approval before the commencement of work.

F22 GENERAL CONDITIONS AND INFORMATION FOR ELECTRICAL WORKS

F22.1 Scope

- (1) This specification covers the supply, delivery to site, site erection, testing and commissioning of all materials and equipment required in connection with the electrical installation works.
- (2) All works specified in these tender documents and any other amendments documents that may be submitted to the contractor before or during execution shall form part of the contract.
- (3) All non-electrical works associated with the electrical installation works shall be considered as part of this contract. These works would generally include items like transport, forming, fixation, breaking and finishing of civil works and all sundries.
- (4) Only the basic requirements of the electrical works and various systems have been specified in this tender document. The contractor shall supply all relevant, materials, accessories, protections etc to make the installations and system complete in all respect. The electrical installation work shall therefore comprise of:
 - (a) H.T. and L.T. switchgear
 - (b) All types of transformer sub-stations
 - (c) H.T. and L.T. cabling
 - (d) All switching and control devices
 - (e) Completely wired outlets for lighting, telephone, call system, switched sockets, etc.
 - (f) Earthing of system and equipment earthing.
 - (g) All the system mentioned in the bill of quantities.
 - (h) Outdoor and perimeter lighting.
 - (i) Special equipment like lifts, escalators,
 - (j) Lifting fittings.
 - (k) All accessories, protection and sundries required to make the entire installation and systems complete in all respects.

F22.2 Project

- (1) Supply, delivery to site, erection, testing and commissioning of all materials, equipment and systems as defined under '1' above shall be known as the 'project'.
- (2) The Contractor shall commission the project to the entire satisfaction of the resident engineer.

F22.3 Phase Identification and Labeling

- (1) All the electrical installations and equipments for the project such as cables, feeders, distribution wires, busbars etc. shall have the following colour coding:

Red

Yellow Three phases

Blue

Black Neutral

Green/ yellow Earth

- (2) Phase sequence shall to be counter clock-wise and shall be kept constant throughout the project and comply fully with clause B44-59, table B4 of the IEE regulations.
- (3) All the switchgear and fuse gear shall be clearly labeled by engraving the name on suitably dimensioned plate preferably attached to the panel board or unit through two sliding channels and fixed by non-rustable screws.

F22.4 Electrical Supply

- a. Unless otherwise specified the electrical supply in Iraq shall have the following particulars low volts 230/400 volts 50 Hz., 3 phase, 4 wire system with earthed neutral at the sub-station, High voltage 11 kv 50 Hz, 3phase, 3wire of fault level of 500MVA and in accordance with Electrical authority regulations.
 - (1) All the low voltage equipment to be supplied by the contractor for the project shall be capable of operating with voltage fluctuations of the order of $\pm 5\%$.
 - (2) For the high voltage equipment, the contractor shall co-ordinate with electrical authority in respect of approval, construction, erection and commissioning.
 - (3) All the equipment to be supplied shall conform to relevant B.S. or IEC standards or other equivalent.

F22.5 Site Examining and Climatic Conditions

- (1) The Contractor shall physically examine the project site to ascertain the conditions under which he would be working and the local and foreign staff required to complete the project successfully.

- (2) The Contractor shall include in his costs all the unforeseen expenses for the successful completion of the project as no claims for the same shall be entertained
- (3) The Contractor shall familiarize himself with the climatic conditions prevailing at the project site for the selections of proper equipment for the project. Generally speaking, the climatic conditions should be considered as hot, dusty, dry and tropical.

F22.6 Terminology and Definitions

- (1) Whenever the following terms and (or) words are used in this tender document, they shall be under-stood to have the following meanings.
- (2) Complete or completely; To supply and install multi-item equipment / system in such away that not a single item or component that may affect performance, life, continuity, reliability, efficiency, normality and (or) standard of the equipment and (or) system shall be missing.
- (3) To the satisfaction of the engineer or resident engineer; shall mean his approval, meeting his requirements, his choice, preference, according to his instructions or directive, if he observes so etc.... T.S.O.E.
- (4) Installation(s): shall mean all the works done by the contractor complete in all respects including cabling, wiring, apparatus, equipment, plant, system, etc.
- (5) Engineer or resident engineer, shall mean the engineer in charge of the project or his authorized representative.

F22.7 Alternatives

- (1) Should the contractor wish to offer alternative materials, equipment or system that he may consider to be better than those specified in this document, he is free to do so provided it is supported with documents and explanations.
- (2) The contractor shall have to quote for the specified items even though he may have offered alternatives.
- (3) The alternatives shall have to be quoted for in a separate document with a covering letter.

F22.8 Compliance with Regulations and Standards

- (1) The entire electrical installation and components shall, unless otherwise stated specially or mentioned in the associated tender drawings comply with the following:
 - (a) British standard specifications.
 - (b) British standard codes of practice.
 - (c) IEE regulations and the IEEE recommendations.
 - (d) The International Electro technique Committee (IEC).
 - (e) Iraqi Electrical Authority regulations.
 - (f) Iraqi Telecom. Authority regulations.

(g) Local Bye-Laws.

F22.9 Engineer Site Staff

- (1) The Contractor with the approval of the resident engineer shall post qualified, competent and sufficient electrical engineering staff at site to take complete responsibility of all site works and to supervise all installation, erection, testing and commissioning of the project.
- (2) The Contractor's site staff shall be capable of maintaining co-ordination and liaison with the resident staff, other builders and sub-contractors.

F22.10 Samples and Approval of Materials

- (1) Before placing any order, the contractor shall submit in writing the names of the firms and manufacturers from whom he proposes to buy the required materials, equipment or system. The resident engineer shall give then the approval of the firms or manufactures. For this reason, the contractor is advised to mention more than one manufacturer or firm for each item.
- (2) For the purpose of clarifications and approval, the contractor shall furnish without any extra cost catalogues, technical data, standards, codes and (or) samples etc if asked for.
- (3) The resident engineer reserves the right to reject any materials or equipment delivered to site if the same was not approved by him previously.
- (4) In no case second hand, rusted or old materials and equipment shall be supplied for the project. The materials and equipment shall be the best quality unaffected by transport, handling, humidity, chemicals, fire heat or any other cause that may classify it unsuitable for the project. in all such cases, the resident engineer has the full right to reject the materials and equipment even though the samples or the source of supply were approved.

F22.11 Tests

- (1) During the installation the contractor shall conduct tests at different stages of construction as may be required to avoid complications at a later stage.
- (2) After completion the of works and before the date of commissioning the contractor shall carry out proper tests to the satisfaction of the resident engineer and (or) his representative and make sure that all the test results comply with standards, specifications, codes of practice etc. Stipulated in this tender document .
- (3) The Contractor shall also submit routine and type test certificates in respect of equipment and materials from their suppliers duly endorsed by an internationally recognized authority.
- (4) The resident engineer or his authorized representative shall then decide acceptance "or" rejection of the test results.
- (5) The rejection of test shall automatically lead to replacement of materials or equipment, rectification of wrong installation totally or partially as may be advised by the resident engineer or his authorized representative. This shall not cause price changes.
- (6) The installation should pass the inspection tests or any other relevant test required by local authorities like Electrical Authority, Telecom Authority, Municipality, etc.

- (7) Where destructive testing is called for by recognized standards or the resident engineer, the contractor shall have to supply the test samples at his own cost.

F22.12 Measurements of Quantities

- (1) The bill of quantities has been prepared with the overall concept of the project. There may be variations in quantities for the achievement of the project. These variations may come up before or during installation work. The contractor shall bring these variations to the notice of the resident engineer.
- (2) The Contractor shall have to supply, install, erect, test and commission additional quantities of materials or equipment required by new variations or by inexactness or measurements as quoted in the bill of quantities and shall arrange that with the manufacturer.
- (3) In the event of the contractor having to execute any additional work or provide any material and equipment not stated in the bill of quantities and (or) not usually understood to be included within complete equipment or labour and to which he proposes to make a claim for payment shall obtain a written order from the resident engineer and shall make arrangement for additional measurements in his presence.
- (4) No reorganization shall be accorded to any measurement not recorded in the presence of the resident engineer or provision of materials made without the written authority of the resident engineer.
- (5) The resident engineer shall have access to the contractor's time and progress book at all times which may be kept with the contractor's time keeper.
- (6) All measurements shall be recorded in metric system unless otherwise stated.

F22.13 Drawings

- (1) Contractor shall be supplied with all tender documents, including three sets of drawings. He shall be supplied with further sets showing variations, additions or deletions.
- (2) If the Contractor wishes to obtain additional copies of the drawings, he may do so by paying extra cost.
- (3) The attached set of drawings show the general arrangement of equipment and installation from the project concept view point. The contractor who is awarded the project work shall prepare at his own cost all working drawings. He is advised to keep close liaison with the consultants through the resident engineer.
- (4) On completion of the project the contractor shall submit to the resident engineering three well bound hard back sets of drawings showing the actual installation of all times, plant, equipment, wiring etc. These drawings shall clearly indicate all positions dimensions sizes, ratings, routes, materials etc to make the drawings self explanatory and complete in all respects out of the three sets of drawing one set shall be soft ware copy.
- (5) The Contractor shall have to supply sets of drawings required by the resident engineer which the latter may feel necessary for keeping record of the installed work. Provision of these drawings shall not cause any extra cost of claim by the contractor.

F22.14 Commissioning

- (1) On the completion of the project as whole or part thereof as required by the resident engineer the contractor shall carry out all tests as required under clause 1.11 of the document.
- (2) Before the date of commissioning the contractor shall conduct general acceptance tests to plant, equipment and installation as required by the resident engineer and (or) internationally acceptance standards. The pre commissioning acceptance tests shall lead to the commission date only if the resident engineer is satisfied with the acceptance test results.
- (3) On the date of commissioning the contractor shall set all controls regulators, relays etc as required by the normal operation mode and shall demonstrate to the satisfaction of the resident engineer that every piece of equipment plant and or systems are in perfect operational condition.
- (4) Unless limited by practical or technical difficulty the entire installation shall run on maximum demand load for a maximum period that shall exceed the warming up period of the equipment and then shall extend to the steady state continuous full load operation for a period specified or required by the resident engineer.
- (5) Commissioning shall be considered as complete when the resident engineer or his authorized representative, certifies in writing his acceptance and taking over of the equipment, installation and systems provided that the contractor by this instance has handed over the following documents to him:
 - (a) Three sets of drawing required per clause 1.13.4 of this tender document
 - (b) Three sets of manuals for operations and maintenance of all equipment, devices, plant, instrument, system for project. These manuals shall be in English language.
 - (c) All documents mentioned under various clauses of this tender document.
 - (d) All sets of spare parts, tools recommended by the manufactures by authentic letters from them.

F22.15 Guarantee and Maintenances

- (1) The Contractor shall guarantee the whole installation, plant, equipment, system etc for the minimum period of one year commencing from the date of commissioning and signing of the taking over document by the resident engineer.
- (2) The above clause shall not cancel or relieve the contractor from longer periods of guarantees mentioned in specific clauses of this tender document or offered by the manufacturers in their catalogues, documents, technical sheets or in the form of letters. The guarantees offered by manufactures to the contractor shall automatically understood as guarantees offered to the resident engineer and the contractor shall be responsible to fulfill all such guarantees.
- (3) The Contractor shall furnish the resident engineer with authorized guarantees from the manufacturers for some items, equipment or materials if the resident engineer may desire. This shall not in any way relieve the contractor from his responsibilities as the principal and sole and sole guarantees technically and legally.

- (4) During the guarantee period the contractor shall be responsible for all maintenance work on the project as maybe required. The contractor shall provide at his own cost all labour, transport, supervision, material, equipment, system accessories etc. to rectify all faults and malfunctions. All replacement of parts, installations, equipment, plant and system etc. shall bear the same guarantees as their originals.

F22.16 Other Works

- (1) The Contractor shall be responsible to do all civil works at his own costs which maybe associated with this project as defined in this tender document. These works may include trenches, ducts foundations, inspection manholes and all other works associated with the electrical installation.
- (2) In addition to the above clause he shall be responsible to provide, install and commission at his own cost all cable trays, supports, concrete and metal works cover floor plates to cover indoor trenches, soldering, welding, brazing, glanding, cutting forming etc. and all similar works related with the installations and project as a whole complete in all respects.
- (3) The Contractor shall be required to keep his site generally clean. Before winding his work the contractor shall clear all rubbish, waste debris, remains, wrapping, empty boxes from the project site and shall provide all finishing touches to the site.

F23 MATERIALS, EQUIPMENT AND REQUIREMENTS

F23.1 General

- (1) This part of specifications is to light the materials and equipment to be used for the project to meet requirement.
- (2) All clauses of this part of the contract shall be real in conjunction with other parts.
- (3) The description of the various materials, equipment and methods is for the purpose of setting guide lines for the contractor and shall not in any case relieve him form complying with the various standards and codes referred to in part 1 of this tender document.
- (4) No clause of this tender document shall be read to cancel or over ride another clause. Incase of any doubt the contractor shall approach the consultants through the resident engineer. The decision of the consultant shall be final and binding.

F23.2 Earthing

- (1) Earthing shall be the term used for electrical connection to general mass of earth. It shall be classified as under:
 - (a) system earthing
 - (b) equipment earthing
 - (c) lightning system earthingIt shall be employ to restrict to voltage of live phases with respect to the potential of the general mass of earth to a value consistent with the insulation level.

Equipment earthing belong to the second category shall signify earthing of non current carrying metal parts of electrical equipment.

It should be particularly noted that protective multiple earthing system is not permitted in Iraq.

- (2) System earthing shall be treated as separate system and shall not be interconnected with any other earthing system like lightning protection earthing system etc. System earthing in general shall meet the requirement laid under BS:GP1013 of 1965 or its latest edition. The following guide lines may however be kept in mind in particular.
 - (a) All transforms will have their neutrals solidly earthed unless stated otherwise on drawings.
 - (b) The type and the size of the neutral earthing cable for each transformer has been shown on the relevant drawings.
 - (c) The total resistance to earth of the system earthing shall not exceed one ohm as measured by a sensitive megger.
 - (d) As far as possible the earth electrodes shall be located adjacent to the building housing the equipment.
 - (e) The number of electrodes shall be enough to get the resistance value stated in c above.
 - (f) There shall not be any break or joint in the system earthing cable.
 - (g) All connections between various electrodes shall be brazed and shall not be riveted nor bolted.
 - (h) As mentioned earlier the system earthing shall be treated as a separate system.
- (3) Equipment earthing in general shall meet the requirements laid under B.S:G.P. 1013 of 1965 or its latest edition. The following guidelines may however be kept in mind particularly:
 - (a) Every feeder, sub-feeder, circuit or sub-circuit shall have its own earth continuity conductor of cross section area not less than one half of the largest current carrying conductor feeding the circuit . However in no case the cross section area of the earth continuity conductor shall be less than 2.5mm² of copper or need it to be more than 70 mm² of copper.
 - (b) Conduits, cable trays, trunking etc. shall not be used as a sole earth continuity conductor. However these shall serve as supplementary earth fault path.
 - (c) There shall be complete earth continuity throughout the entire system in accordance with IEE regulations. With all necessary bonding provided and installed by the contractor complete in all respects.
 - (d) Test shall be carried out as the work progresses to check the electrical continuity of all metal and earth continuity conductors.
 - (e) All sinks, water pipes, hot and cold pipes etc shall be bonded.
 - (f) The incoming gas and water services shall be bonded to the electrical earth as near as practical to the point of entry to the building (s).
 - (g) All non current carrying metal parts of the electrical equipment and appliances & the earth terminal of socket outlets shall be connected to earth.

- (h) The earthing arrangement of all the installation shall be such that on the occurrence of a fault of negligible impedance from a phase or on earthed conductor to adjacent exposed metal, a current corresponding to three times the rating of the fuse or one and a half times the setting of the overload circuit breakers can flow, so that faulty circuit is made dead. Under fault conditions the voltage developed between exposed metal required to be earthed and the earth terminal of the system should not exceed an r.m.s. value of 10 volts.
 - (i) The project earthing system shall be effected by connecting the earth lead of a single core pvc insulated cable laid inside a rigid galvanized steel conduit or G.I. pipe and connected rigidly to the earthing electrode system. This rigid mechanically strong connection shall be made in such a way that the connection can be opened for inspection and measurement.
- (4) Earthing electrodes network shall be placed in a rubble free area not far from the building foundations but in no case shall be closer than 2.5 meters. The earth electrodes shall be of copper rods 20 mm diameter. The electrodes shall be made with standard length of approximately 120cms supplied with screwed coupling arrangement so that more than one rod can be coupled and driven in the ground to form an electrode. The first rod shall have a tapered head at the leading end and threaded bore to a depth of 25 mm at the other end to receive the next rod. All sub-sequent lengths shall have thread bores at both ends for coupling them. Before the entry electrodes are installed the contractor shall measure the earth resistivity of the soil and shall record four measurements at four different spots using four electrodes null method in straight line pattern with a 500 v earth tester instrument. The results shall be recorded in his report or the relevant drawing. After the installation is complete, the resistance of the unconnected and untreated earthing system shall be measured by three electrodes method using a sensitive earth tester instrument.

Should the resistance to earth be above specified limits rods may be added or more electrode points be established to achieve the required results. All earth electrodes shall be formed in parallel and shall be installed in association with the following :

With every main switchboard fed directly from sub-station.

- (a) With every main switchboard fed from another main switchboard and not located in the same building block.
- (b) Any place or equipment specified or shown on drawing or recommended by manufactures or other authorities as relevant.

It may be pointed out that connections between electrodes shall be made by copper conductor having a cross section area of not less than 70mm². This conductor shall be buried without any mechanical damage at depth not less than 45cms.

F23.3 Metal Conduit System

- (1) Unless otherwise specified, the metal conduit system shall be entirely concealed in walls, ceilings, slabs and floors except in rough service area like air handling rooms, plant rooms, light machine room etc.

- (2) Metal conduit installation specified herein shall be carried out in heavy gauge hot dipped galvanized screwed welded conduit unless specified otherwise and shall regarding material installation etc comply with BS. 4508 part I and II or BS. 31 and BS. 731 for rigid and flexible conduits respectively and with IEE regulations clauses B.87-109.
- (3) General requirements of conduit system:
- No conduit of less than 20mm diameter shall be used in work under this specifications. Conduit sizes shall be in accordance with the relevant tables set out in the IEE regulations (latest edition) plus 10% for future possible additional cabling. All conduits shall be free from rust patches of mechanical damage and shall be adequately protected from all types of damage when stored on site.
- All draw boxes and junction boxes be of ample size to permit the cables going draw in and out. They shall be of a malleable iron or heavy gauge sheet steel hot dip galvanized.
- All circular boxes shall be provided with long spouts internally threaded, incorporating a shoulder for the proper butting of the conduit. Standard circular boxes shall be installed at all lighting points except where conduits terminate at fixed lighting fitting having provision for direct conduit entry (eg bulkhead fitting).
- At lighting switch points the conduit shall terminate in suitable box provided with internal adjustable lugs to permit back plates or switch grids being attached to them by metal threaded screens. All like for draw boxes etc. shall be of heavy gauge welded sheet steel pattern overlapping lids shall be provided for flush boxes.
- The ends of all conduits shall be cut square and shall be inserted solidly into the conduit fittings where they terminate in switchgear fuse board trunking adaptable boxes or other non-spouted enclosures etc. they shall be connected there to by means of smooth bore male brass bushes, compression washers and sockets. The length of thread cut on conduit shall be kept to minimum consistent with the above requirements running threads will not be permitted for coupling. An approved type of coupler shall be used where necessary. In all cases castellated lock units shall be used and the use of ring bushes and locknuts shall not be permitted.
- (4) Flexible conduit shall be made of galvanized sheet strip presenting two convey surfaces one to the inside and one to the outside of the conduit and wound helically inter locking the two surfaces.

F23.4 Metal Conduit Installation

While installing the system the following points shall be taken:

- where conduits pass through unplastered walls they shall be installed in their position during bricklaying time.
- Where conduits are installed in the ground they shall be first coated generally with asphalt, allowed to dry thoroughly before installation. Watertight arrangement shall be made for conduit installed near or in damp places.
- All conduit risers shall be rigidly supported by the building structure.
- All conduits run to the distribution board shall have neat flat accurate pattern emerging from floors and ceilings at right angles.

- Conduit system shall be properly and continuously earthed but it shall not be used as sole earth continuity conductor.
- With the exception of points of crossings and panel boxes, all conduits shall maintain a minimum separation between one another of three times the outside diameter of the larger diameter and shall have a minimum clear distance of 25mm to finished parallel concrete surface.
- In ceilings, conduits shall be under the reinforcement malting and shall rest on spacers of 5mm height to allow concrete to cover conduit from all sides.
- Bends shall be nearly and accurately made with proper bending machine such that internal radius of the bend shall not be less than 3.5 times the outside diameter of the conduit.
- Exposed screw threads shall immediately after installation be coated with aluminum paint.
- All motors and recessed fitting in false ceilings and else where shall have their final connections lead via flexible conduits secured with flanges at both ends.
- Across expansion joints weather proof galvanized flexible conduit shall be used.
- Boxes shall not load the conduit but shall be fixed freely and independently to the building structure.
- Outlet boxes for switches and sockets shall be installed true and square with the building finish.
- Full boxes shall be installed as required for easy drawing of wires.
- Not more than two right angle bends shall be used between pull points.
- Bar hanger shall be used to support outlet boxes in suspended ceilings and similar structure. Hangers for lighting fixtures shall have suitable studs.
- No wire or cable shall be drawn inside conduit before it has been completely installed and plastered over.
- Efficient means shall be provided to seal boxes and fittings against the ingress of dirt during the building construction.
- Only proper drag in tape with approved lubricating powder shall be used for drawing the wires.
- No two services shall run in one conduit system.
- Exposed conduits installed parallel with or at right angles to the adjacent wall. When their location is underneath or alongside of other ducts for ventilation, heating etc. the conduit shall be supported independently of the ducts. Conduit hangers or supports shall not be spaced more than 2.4 meters apart.
- Conduits for their surface runs shall be secured by spacer bar saddles at intervals not exceeding 1500mm. Fixing saddles shall also be provided not more than 100 mm on either side of the fitting. Where it is necessary for example at concrete joints and for conduits larger than 25 mm diameter concrete inserts shall be used and conduits shall be supported by cast pipe rings or round rods.
- Conduits shall be installed at least 140mm clear of the preferable under, hot pipes and 50mm clear of gas, water and other services.
- All conduit fittings installed exterior to buildings shall be fitted with efficient permanent gaskets in order to render these water tight. Conduit boxes shall also

be compound filled if the installed conditions are such as to require this. The enter system shall be installed with the consideration to the building finish like tiled walls etc. the contactor shall watch and coincide with the building finish in co-ordination with the civil contractor.

F23.5 Cables

F23.5.1 General

For the purpose of this specifications the cables shall be classified in four categories as follows:

- Cables for final sub-circuits (wiring).
- L.t. cables used inside the buildings.
- H.t. cables
- Special cables.

All cables shall be delivered to site with markers seals and labels. The labels and seals shall not be removed until the cable is required for use and shall be retained for inspections by the resident engineer. All cables shall have standard conductors which shall be of copper. All cables shall have colure codes in accordance with IEE regulations.

F23.5.2 Cables for Final Sub-circuits

All cables shall be single core pvc insulated stranded copper conductors of 250v grade minimum complying in all respects with B.S. 6004:1969 of its latest amendments.

F23.5.3 L.T Cables for Indoor Installation

All cables shall be multicore, PVC insulated, PVC sheathed, stranded copper conductors of 600/1000v grade with cross section areas as shown in the relevant drawings. The cables shall comply in all respects to BS 6346:1969 with its latest amendments.

F23.5.4 L.T Cables for Outdoor Installation

These cables shall be similar to the above type but shall be provided with armouring and outer PVC sheath.

F23.5.5 H.T Cables

Unless otherwise mentioned on drawings, all H.T. cables shall be paper insulated, belted lead sheathed double steel tape armoured and served with overall PVC sheath having stranded copper conductor suitable for operation on 11000 v minimum conforming to the latest edition of B.S. 6480.

F23.5.6 Special Cables

For the special cables for systems like fire detection, boiler rooms etc the contractor shall specify in his offer the types of cables he proposes to use. The final choice of the cables to be used shall rest with the resident engineer or his consultants. The contractor shall obtain this approval in writing.

F23.6 Wiring

Wiring for the various systems shall be carried out by single core wires drawings in heavy conduit. Each system shall be wired completely independent from the other. Number of wires that can be drawn in any conduit shall not exceed the following limits:

Size of wire mm	Max. number of wires that can be drawn in conduit of diameter		
	20mm	25mm	32mm
1	7	12	25
1.5	5	10	20
2.5	4	9	12
4	3	6	10
6	2	4	8
10	2	3	5
16	---	2	3

While drawing wires, the following precautions shall be observed:

- All necessary precautions shall be taken to prevent hysteresis circulating currents.
- This shall include the slotting of any ferrous plates through which the cables pass.
- No through joint will be permitted in any cable.
- The ends of all cables shall be stripped with a special stripping tool made for the purpose.

All the strands shall be soldered before termination.

F23.7 Terminations of Paper Insulated Cables

Suitable terminal and sealing boxes with wiping glands, terminal lugs, armour clamps cable compounds, tapes plumbing metal etc. necessary to terminate the cables shall be provided by the contractor and shall form as an understood part of the contract. Cable ends shall be brought to the terminal point through relaxed bending position with enough length of cable in such a manner that no mechanical stress shall strain the terminal connection. Where the dead end of the cable may strain the terminal connection, cable shall be clamped in a suitable manner to relieve the stress. Wiped joints shall be made between the lead sheets of the cables and the glands on switchgear, transformer, machine etc. The metal sheathes and armouring of cables shall be efficiently bonded to the cable sealing boxes by means of copper tapes.

In all cases where cores of paper insulated cables are exposed, other than for immediate jointing, the end of the cable shall be sealed by means of a lead cap plumbed to the lead sheath of the cable immediately after the lead exposure is made. All terminations shall be made on a dry day and shall be completed on the same day. Adequate precautions shall be taken always by; the contractor to prevent the ingress of moisture into cable insulation and cores.

Straight through joints shall not be allowed except when the cable run exceed that of the manufacturer standard drum length. Where this condition applies no joint shall be in or close to duct street or building. Joints shall not be permitted unless otherwise specified. Joints shall be provided with insulation level not less than that of the cable.

All materials like joint box tapes, cable compound etc. shall be of the high quality. In general joints and jointing shall confirm with IEE regulations B 73-78 and all instructions of the cable jointing kit supplier.

F23.8 Cable Terminations of PVC Cable

Cable glands of type approved by the cable manufacturer shall be used for all cables entries to switchgear etc. all intersections and junctions of routes of cables in ducts and trenches, each cable shall be identified by engraved brass label securely fixed to the serving of the cable .The armour sign of each cable shall be brought out to the cone shaped armour clamp. The terminating gland shall be fixed to the equipment by a clamping nut and a locking nut. All glands shall be in accordance with BS 4121 and shall have a PVC overall shroud. Normally cable jointing is not permissible unless the length of the cable exceeds the drum length supplied by the manufacturer or special agreed by the resident engineer the method of jointing shall be as described previously for paper insulated cables except that a self adhesive non hydroscopic tape shall be used in place of a lead cap for immediate sealing.

F23.9 Cable Laying

1. Direct-ground laying (type "A" laying)

Direct- in the ground laying of power cables when specified shall be in excavated trenches and according to the following particulars:

Trench depth x width 50x45cm for L.T cables

90x45cm for H.T cables

Fine dry sand bedding

(thickness) 10cm

Protective tiles 40x20x50cm

Cable protective tiles shall be subject to the approval of the engineer.

- a. Reinforced straight covers of the flat type.
- b. Unreinforced concrete.
- c. Earth upward (complying with B.S.2484 1961).

Interlocking arrangement against laterals movement shall be provide by concave convex ends, and the upper side of the title shall have the word (كهرباء) (electricity in Arabic) impressed longitudinally and to a depth of 3.5mm.

Whenever more than one cable is laid in a trench separation of the cables should not be less than 10.0cm from surface.

Whenever more than one cable are laid inside a trench suitable plastic or lead cable markers shall be fixed to each at 2.0m intervals with inscription carrying identity name or symbol for the cable as well as the system voltage.

At streets, walkways, roads, wall or/and foundation crossing cables shall be drawn through concrete, asbestos, cement, galvanized steel or burnt clay pipes laid at a depth of 70cm covered with a 4-5cm layers of concrete mixture in site and projecting off the crossed object by a minimum of 50cm at near side.

The internal dia. of the crossing pipes shall be not less than 10cm and the radial thickness of concrete-mixture or burnt clay ducts shall not be less than 15cm (or the nearest available standard upwards).

Concrete or screed ducts shall be used in association with rubber-insulated braided and completed cables or nonsheathed P.V.C insulated cables.

Generally multi-core power cables shall be one cable per duct unless otherwise specified for a multi-duct crossing the ducts shall be touching one another.

2. Open trench or duct lying (laying type B):

Cable shall be laid in concrete trenches and/or ducts in the places shown on the drawings. Ducts shall be at 70cm depth.

The covering reinforced concrete tiles shall be provided with two surface-flush steel eyes or other similar arrangement approved by the engineer to facilitate lifting of the tiles.

The trench and /or the duct run shall be provided with inspection manholes at each start, finish, bend and at intervals of not more than 15cm. The manholes shall be 100x100x70cm for indoor trenches square plates shall be supplied.

Minimum clearance between the trench wall and the adjacent cable surface of all fixed cables shall be 25mm or one cable outer diameter which is greater.

When especial trenches are specified particularly for multi-service cables the arrangements of cable and wires shall be such that the cables of higher voltage are placed above those of lower voltages.

3. Surface-clipped laying

Inside building and where it is shown on the drawings cables shall be laid on :walls or ceilings with horizontal or vertical runs.

The cable shall be clipped to the surface by suitable high quality plastic or metallic saddles for single cable runs or galvanized steel clips with foam pads in case of multi-clips for multi cable runs to reduce mechanical stresses on the cables.

Metallic mounting channels of standard size shall be used. The fixation shall be through properly-sized plastic or steel expansion type lugs ended in properly-drilled holes.

In every clipping arrangement it shall maintain a clearance between the cables outer surface and the wall surface of not less than 20.0mm or one cable overall diameter, which is greater.

The spacing of supports along the cable run shall not exceed 450.0 and 300.0mm for vertical and horizontal runs respectively, or according to table B.2M of IEE regulations.

4. On-cable-trays (laying type D)

Cable run from distribution boards to other boards or special – purpose or control boards as relevant shall be grouped and laid on galvanized, perforated sheet-steel heavy gauge cable trays of standard dimensions.

The trays shall be supplied complete with all fixing and clamping accessories then installed in the locations as on the drawings or as emerges in the contractors working drawings.

Galvanized steel brackets shall be used for fix the trays to the ceilings or to the wall in a horizontal pattern. Sufficient clearances shall be maintained between ceiling and the tray. Cables shall be laid nearly and straightly with a minimum separation between adjacent cables of not less than 1.0 time cable diameter.

The trays and brackets shall be approved by the engineer before ordering and installation. The cables shall be fixed to the trays, by metallic or plastics saddles.

5. I-cable Trunking Lying (laying type E)

There it is specified and shown on the drawings cables shall be grouped together and run in enclosed, dust proof, rust resistant hot dipped heavy gauge, 20-S.W.G. sheet steel trucking of rectangular cross section returning edges, removable of standard dimensions.

Trunking shall be supplied complete with fittings and accessories such as screws, galvanized brackets, iron angles, supports ends, couplings reducers, bushes, multi-way boxes, fire barrier, elbows, bends, tees etc. all properly sized.

Trunking shall run either fixed on walls, suspended from the ceiling or/and under floor as shown in drawings or specified. In every time the trunking shall be made one mechanical and electrical body through copper continuity links and its construction and cable laying shall have space factor not exceeding 30%.

Segregation of power cables from communication and/or control cables shall be strictly observed.

F23.10 Cable Trays

The Contractor shall be responsible for the supply and erection of cable trays, racks, etc. for supporting the cabling. He shall supply and erect all allied materials like brackets, clips, cleats, hangers and other steel work. All cable trays shall be of perforated steel with a suitable upstand at each side. Trays shall not be constructed for steel gauge thickness less than 14SWG. All tees and bends shall be hot dipped

galvanized. where trays are cut, the cut ends shall be adequately rust proofed and painted with cold galvanized paint. Cable trays shall be adequately supported at intervals such that the trays does not bend under the weight of the cables. Where supports exceed 800mm the cable trays shall be reinforced with mild steel angle of adequate section running along the tray. Each support shall consist of an angle or channel steel braced underneath the full width of the tray with 10mm diameter mild steel rod support or suitable angle brackets where the tray is supported from the wall. In the latter case the trays must be spaced at least 5cm away from the wall. All such supports shall be galvanized. All cable trays shall be free from burrs and sharp edges. Joints in trays shall be made at supports and shall not overhang the supports. Electrical continuity of the cable trays shall be maintained by 25mmx3mm thick copper link across each break or joint in the system. Connections shall be made by means of brass bolts, flat washers, spring washer and nuts of appropriate size. At the link position the finish shall be removed within 6 mm of the jointing strap and the exposed metal primed. The entire system shall be bonded to earth. Where the installation of cable trays involves use of bends and tees, these shall be made by fittings manufactured for this purpose and not by cutting or modifying straight tray section. Where slotting of cable trays in carried out for cable entry or exit, a PVC protective edging shall be provided on the edges of the slots.

F23.11 Cable Trunking

The cable trunking shall be manufactured from steel of gauge thickness not less than 16 SWG. In special cases the steel trunking may be used after obtaining approval from the resident engineer. The trunking shall be made out of corrosion resistant steel and shall be provided with a removable lid throughout its length. Trunking of all sizes shall be secured at intervals of not more than 1.0 meter and joints shall not overhang a fixing by more than 0.5 meters. Openings for conduit connections shall be provided as required.

Suitable units shall be used for branch connections, bends alterations in section, cable retaining devices etc. Cable leaving or entering the trunking shall be suitably supported to prevent damage or under pressure on the installation. where partitioned trunking is used, the partitioning shall be maintained at intersections and angle pieces. Where metal trunking passes through walls and ceilings, the cover shall be solidly fixed to 25mm either side of walls and 150mm either side of the floors and ceilings. Where switchgear and fuse boards are secured to metal trunking (if so specified or shown on drawings) such connections shall be made by necks and not by multiple conduit couplings. To prevent abrasion of cables on sharp edges when metal trunking is slotted, PVC mouldings shall be securely fixed around all such areas. Vertical sections of metal trunking over 900 mm in length shall have staggered insulated tie off studs to support the weight of the cables. Cable retaining straps shall be provided at not more than 0.5 meters spacing. All trunking system shall be painted with a complete finish so that of the original where any abrasions to the original have occurred. The trunking shall be sized in accordance with the IEE regulations and with an additional included allowance of 10% for future installation. The entire installation shall be carried out in such a manner that no damage comes to the cables which shall be installed in them.

Electrical continuity shall be ensured by the provision of approved copper continuity straps at all bolted joints in the trunking. All the bends and toes shall be prepared and welted at the manufacture's works and shall not be constructed at site.

F23.12 Rising Main Bus Bar Trunking

Where this system is specified in the bill of quantities or shown on the drawings, it shall be provided or installed, erected and commissioned inclusive of all terminations, teeing off switchgear, fuse gear and all other accessories associated with the system. The construction shall be of all metal clad bus bar trunking made from minimum 1.6mm nominal thickness zinc coated sheet steel with detachable screw on covers between floors and fixed sections through floors. Fixing irons shall be fitted across back of trunking giving an air space between wall and case. All metal work shall be finished staved grey enamel, complete with connecting sleeves, copper earthing straps and plated screws, nuts & washers. Busbar supports shall be of laminated insulated material mounted on metal channel and spaced at a distance not greater than 600 mm between centers. The TPN busbars shall be of hard drawn, high conductivity copper and provided with connection links across each joint. The copper busbar shall be PVC sleeved. The entire assembly shall allow for expansion and contraction movement. All the phases and neutral shall be colour coded as per IEE regulations. Tinned copper braided links shall be fitted as required in lieu of the solid links. The rising main busbar trunking shall have a rating as shown on the drawings and shall be provided with all standard features like thrust blocks, fire barriers at each floor, sub circuit wiring ducts if so indicated etc. the incoming feed cable to the rising main shall be as shown in the drawings for which suitable cable gland with all other accessories shall be provided. Wherein alternative method of incoming feed is envisaged, suitable arrangement shall be made on the system to connect teeing off switchgear, fuse gear or the plug in tap off points as the case maybe. All materials and accessories for earthing of the system shall form part of this supply.

F23.13 Overhead Busbar Trunking

This system shall be supplied and installed if so specified on the drawings. It shall have the rating as indicated on the drawings. It shall be installed horizontally attached to the bottom sides of the building beams or in any other suitable standard method. All tapping boxes shall be of the TEN plug in type design. In general specifications of this system shall be similar to the rising main busbar trunking as specified earlier.

F23.14. Isolators Switch Fuses, Fuse Switches And Change Over Switches

Isolator, switch fuses, fuse switches and change over switches shall conform to BS 3185 and shall be metal clad, the cases being of good quality heavy gauge sheet steel, primed bonderized and finished in quality stove enamel to the colour as specified in BS 3810. the cast iron cases type shall be acceptable only after the approval of the resident engineer is obtained in writing however these may be installed in damp areas. All fused switches, switch fuses and isolating switches, whether provided as part of a switch board or as a separate item, shall be capable of carrying continuously, and making and breaking their rated current without deterioration and shall be of the metal clad totally enclosed pattern. All the switchgear as specified above shall be rated for 500 volts 50 Hz system for fault rating of the installed system. The Switching action shall be quick make and break. The fixed contacts shall be fully shrouded, and with the switch in the open position it shall be possible to renew the HRC fuses in complete safety. An ON/OFF position indicator shall be mechanically operated by the moving contacts to give an accurate and positive indication and means shall be provided for locking each switch in the open position. On all fused switches, switch fuses and isolating switches cover shall be interlocked with the operating handle so that it cannot be opened when the handle is on the ON position. All unit type switches where installed shall have undrilled detachable end plates or "knock outs". All switch fuses and fuse switches shall have each pole fused and switched and the neutral shall be linked by means of a

removable bolted hard drawn high conductivity copper. All fused switches, switch fuse and isolating switches shall be fitted with blank end plates for conduit or mineral insulated or PVC/PVC insulated cable entry, or cable boxes, brass cone wiping glands and armour clamps for cable terminations as required. Reverse entry adapters and right angle end boxes shall be fitted where necessary.

F23.15 Miniature Circuit Breakers

Miniature circuit breakers shall be single, double, or/and triple pole with disconnectable neutral link of the moulded- case type for operation with 230/400 V, 4 wire system. The ratings of the miniature circuit breakers shall be as specified in the drawings. Where miniature circuit breakers are installed for protection of these phase circuits, the three phase unit formed shall be interlocked such that operation of any one phase unit will cause the other two phase units to trip. These miniature circuit breakers shall conform to BS 38 part 1 in respect of their making and breaking capacities and shall have a service life not less than 200000 operations. Selectivity should be observed and taken into consideration.

F23.16 Air Circuit Breakers

They shall be 500-volt design, triple pole, airbreak, fixed and/or draw-out type for up to 200 amp and above respectively, time current, thermal over- current release with $\pm 20\%$ adjustment and having:

- Under voltage relay
- Instantaneous electromagnetic short- circuit release on each pole.
- Earth leakage protection.
- Drawn- out type shall be provided with fully automatic and positively- driven lockable B.B shutters. The breaker shall be provided with the relevant mechanism, for movement, locking, and plug- indication of the following positions: isolated, withdraw, test service.
- Visible on-off mechanical indication in the form of transparently covered flag-window arrangement or similar and a luminous indicator in the form of green and indication lamps shall be provided.
- It shall have a quick make and quick break trip free mechanism so designed that the contact motion is independent of the speed and force which an operator may apply.
- Six 15 amp secondary isolating contacts shall be provided, three being normally open and three being normally closed.
- Suitable mechanical interlock to prevent opening doors or covers of the C.B. when it is in the "ON" position and/or being closed on while in movement shall be all incorporated.
- The C.B. shall be provided with push- button tripping arrangement with a "Tripped" flag-type indicator that operates only in tripping situation.
- It shall have vertical entry arrangements, built- in current transformers on the load side of the B.B of adequate ratings and accuracy.
- Breakers shall be back- connected to BBs with studs and shall comply with B.S.4752/1971 and B.S 3871 part 2 and ASTA certified.

- Rupturing capacity shall be not less than 25 Ka r.m.s. at 400 volt and 50 Hz. Making capacity shall be not less than 200% of the rupturing capacity under the same conditions unless otherwise specified.
- Disconnection devices and contacts shall be self aligning and have the disconnecting fingers mounted on the breaker.
- The C.B. shall be provided with a suitable name plate of black bakelite with engraved lettering in Arabic and English.
- An ammeter, a voltmeter and phase selector switches shall be provided.

F23.17 Final Distribution Board

Final distribution boards shall be totally enclosed, factory assembled in a sheet steel enclosure, rust protected and finished staved enamel. Unless otherwise specified these shall be suitable for flush mounting. The entire assembly shall be dust and vermin proof. These distribution boards shall be suitable for operation on 3 phase 4 wire 400/230V, 50 Hz, system. The incoming unit may be a TPN isolator or a fused switch unit as indicated on drawings. The out going miniature circuit breakers shall be of . SPN type. It should be possible to gang any three similar adjacent miniature circuit breakers to convert them to a TPN unit. The distribution boards shall be provided with copper busbar, copper neutral bar, copper earthing bar, directory, schematic diagram labeling, flag colour identification etc. complete in all respects. The boards shall be provided with conduit knockouts in top, bottom and back. The incoming and the outgoing units shall have ratings as specified on drawings.

F23.18 Fuses

All the fuses shall be of HRC cartridge link type.

The bolting fixing pattern shall be suitable for the corresponding switch gear. All the fuse links shall conform to B.S. 88 of category 415 AC 80 and IEC 269-1 having class Q, fusing factors. For motor circuits the ratings of fuses may be changed according to the recommendation of the supplier. For this reason while ordering for the motor circuits, the contractor should send the specifications of the motors to the supplier.

F23.19 Contactors

Contactors shall be totally enclosed in metal cases with hinged and/or bolted covers, be provided with external earth terminals where required for separate wall mounting. Where mounted within a common enclosure, all components of each individual contactor shall be mounted on a common back plate. Separate mounting of contractor and over loads shall not be allowed. Contactors shall generally comply with BS775. The operating coil voltage shall not exceed live/ neutral voltage on a three phase contractor. Where a group of contactors are enclosed in a switch board a separate control transformers maybe used. For cubicle type boards the contactors shall be housed in a separate compartment with its own hinged lid and shall be barred from any other equipment. The arrangement is mainly to be used for fuse distribution panels. All the contactors shall be air break TPN design unless otherwise specified in drawings. The main contacts shall be replicable silver or platinum coated and shall be rated as indicated in drawings or in the bill of quantities. Electromagnetic arc extinction and arc-chutos shall be provided to conform with relevant B.S standards. The expected life of contacts shall not be less than 300.000 make/break. The local and remote ON/OFF push button stations shall from an integral part of the supply. Auxiliary contacts of

No/Nc types shall be provided as required. Over load devices shall be provided as required.

F23.20 Instrumentation

All indicating, measuring instruments, protective relays, current and voltage transformers, selector switches, indicator lamps etc. shall be considered as part of the supply of transformers, switchgear and control gear as relevant and shall not be supplied as separate items in the bill of quantities. Under all normal circumstances the instruments shall be flush mounted at readable heights all selector switches shall be mounted at convenient heights to avoid any difficulty to the operator. The classes of accuracy shall be as per the relevant B.S. according to metering or protection as the case may be.

(1) Instrument voltage transformers shall be installed for measuring control, protection, signaling, synchronization etc. as required, wherever the intensity of system voltage is not suitable for direct connections. The accuracies i.e. the limits of voltage error and phase displacement shall be according to the functional aspects which may be metering, protection, indication etc. and shall be as per the relevant British Standard Specification. The rated VA burden shall match the circuitry. All the instrument voltage transformers connected to a voltage which is by 20% higher than the rated primary voltage.

(2) Current transformers shall be used wherever the intensity of the operating current to be measured has to be reduced to the value for which instruments, meters and other metering and protective devices are designed. At the same time, current transformers shall also be used to isolate metering and protective devices from the system voltage. In respect of accuracies i.e. limit current and phase errors, current transformers shall have their accuracies according to functional aspects such as metering and protection and shall conform to the latest British Standard Specifications. Unless otherwise stated or specially required by the switch gear, control gear manufacturer the rated secondary current shall be suitable to operate continuously on a current of 140% of the marked value.

(3) Ammeters

Ammeters of the indicating type shall be M.I.S.C flush mounted square or rectangular- pattern with suitable scale, and current range as in drawings or bill of quantities and capable of withstanding a continuous overload of 120% times the maximum value of effective range and withstanding sudden loading. Where three phase current measurement are involved ammeters shall be:

- Single ammeter equipped with 3-position selector switch marked R.Y. & B.
- Three ammeters connected continuously to the three phases one ammeter for each phase and marked R.Y. & B.

The ammeters(s) where relevant shall be equipped with CTs of transformation ratio as indicated or as design of equipment implies.

(4) Voltmeters

Voltmeters of the indicating type shall be of square or rectangular- pattern flush- mounted with suitable scale and voltage range of:

- 0-300 volt for phase- to-neutral in 1- phase measurements
- 0-500 volt for phase-to-phase in poly-phase measurements

In poly-phase circuits the voltmeters shall be provided with 6-position selector switch to read phase to phase and phase to neutral voltage. It shall carry stable and clear markings as follows R-Y, Y-B, B-R, R-N, Y-N, B-N, (and) off. The voltmeter shall be provided with insulation sufficient to withstand over voltages up to 1000 volt. Each voltmeter shall be provided with a set of HRC protective fuses and one spare set. Where voltmeters are connected via, voltage transformers they shall be calibrated to read primary voltage directly.

(5) KW meters

KW – meters of the indicating type shall be when specified supplied and installed complete with wiring, protective fuses and etc.

The meter ranges shall be as to measure 120% of the full load as shown in drawings. They shall be of square or rectangular pattern fitted with Ferro dynamic movements. The instrument shall have a design voltage of 500 volt to operate with a certain degree of un-balance. It shall be an integral part of the board to which it is attached provided with CTs and/or PTs when necessary and of industrial type accuracy.

F23.21 Lighting Fittings

Lighting fittings shall be supplied with tubes and/or bulbs, starting gear, control gear, P.F. correction capacitor etc. Internal wiring of the fixtures to the internal connecting block shall be furnished by properly sized heat-resisting wires (e.g. silicon rubber). Contractor shall supply the fittings of the types indicated hereafter or equivalent to the performance quality and appearance to the satisfaction of the engineer and they should be purchased from a well known international firm. Metallic parts or components shall be treated with anti-rust, corrosion coatings. Outdoor fittings should be completely weather proof.

Fluorescent fittings shall be of the switch – start, power- factor – corrected. Every fitting shall be supplied with suitable connecting block for looping-in wiring from fitting-to-fitting and with internal fuse. Colour description of the light shall be as that in the IES interior lighting design 4th Edn. The contractor shall supply the fitting according to the "classification of fitting" as detailed in this document.

Final connection from lighting outlet to lighting fitting shall be carried out by using either armoured flexible cable or flexible galvanized steel conduit and connection with normal wires without the necessary mechanical protection shall not be permitted.

F24 VARIOUS SYSTEMS

F24.1 Transformers

The transformers shall be of the ratings, type (indoor /outdoor / flameproof etc.) as indicated in drawings and/or mentioned in the bill of quantities. They shall be, unless otherwise mentioned, oil immersed, power transformers, floor mounted, core type complying fully with BS : 171:1970.

The sizes of transformers shall be such that they can easily be accommodated in the substation in the space allocated to them.

The 11 KV cables shall rise directly from the trench and connect to the gland assemblies and the transformers.

Transformers shall be supplied with cable box on the H.V. side suitable for XLPE cable of 11 KV grade of the type and size shown in the drawing .

When the L.V. side of the transformer connects the L.V. switch-gear, by TPN copper busbar trunking a large terminal box shall be provided on the L.V. side of the transformer for this purpose. The contractor shall ensure excellent co-ordination between transformer, busbar trunking and L.V. switchgear suppliers for effortless fitting and matching. However in case the L.V. side of the transformer is cable/cables connected a suitable arrangement shall be made on the L.V. side of the transformer to receive the type and size of cables indicated in the drawing. To meet the requirements of BS 171 the type tests and the routine tests certificates shall be supplied by the manufacturer. The transformer ratings as shown in the drawing (s) shall be considered as maximum and continues . In addition it shall have the following parameters.

No. of phases: 3

Frequency: 50 HZ

Voltage H.V. primary: 11000 V

Vector Group: DYN 11

H.V. Tapping (Five tappings for): $\pm 2\frac{1}{2}\%$ and $\pm 5\%$ by off load tap switch.

L.V. volts at no load: 416V

Temperature rise: Top oil 45C by thermometer

Winding 50C by resistance

Cooling: ONAN

Standards Applicable: BS 171:1970 or latest issue, or other equivalent .

Oil: BS 148:1972, or other equivalent.

All standard accessories like conservator, silica gel breather, thermometer, lifting lugs, earth lugs, rating and connection plates. Buchholz relay, base skid drilled and fitted with roller axels etc. in all respects.

Spare parts for five years as recommended by the manufacturer.

F24.2 Main L.T.Switchgear

The L.T. switchgear are to be used on the L.T. side of the transformer specified in clause (3.1). The switchgear is to be indoor type, free standing, floor fixing, with ventilation louvers with mesh screen . The cabinet is to be water – proof and entirely protected against the danger of vermin and dust the degree of protection is to be (IP 44).

The switchgear enclosures shall contain power distribution equipment like: busbar, circuit breaker, suitable heavy duty contactors, relays, control equipment, etc . The included electro – mechanical components are to be of robust construction.

The synthetic material should be resistant to the atmospheric conditions and immune from corrosive actions of chemical and fire proof. The construction is to be with front access only with hinged door opening at 180 angle with locks.

F24.3 Lightning Protection System

All buildings and structures, which are susceptible of getting lightning strikes by virtue of their height or location shall be protected. Such susceptible buildings and/or structures have been indicated in the relevant documents quantities . In case buildings or structures are not indicated in the bill of quantities then they shall require no lightening protection . For the protective system to be effective the system shall be designed and maintained with a low ground resistance . The system shall be designed as per British standard code of practice CP 326:1965 and shall have the following salient features:

- (1) Interceptors or air terminations intended to collect lightning discharge from the atmosphere shall project at least 30cms above the object on which they are fixed. Air terminations shall be spaced 15 to 23 meters apart. Salient points, even if they are less than 15 meters apart, shall be provided with separate air terminations. For a flat roof, air terminations shall be provided along the outer perimeter of the roof.
- (2) In order to extend the zone of protection, network of parallel horizontal conductors shall be installed. No part of the roof should be more than 5 meters from the nearest horizontal protective conductor.
- (3) All metallic projections, ducts, vent pipes, gutters etc on or above the main surface of the roof of the structure shall be bonded to and form part of the air termination network. The method and nature of fixing shall be simple, solid and permanent.
- (4) If portions of a structure vary considerably in height any necessary air termination or air termination net work of the lower portions should, in addition to their own down conductors be bonded to the down conductors of the taller portions.
- (5) Conductors which connect the air termination network to the earthing known as " Down conductors" and they should be positioned no more than 20m apart around the perimeter at roof or ground level which ever is greater . If the structure is over 20m in height, then the spacing is reduced to every 10m or part thereof.
- (6) All down conductors shall be distributed round the outside walls of the structure. As per BS 2655 life shafts shall not be used for this purpose. For all other special cases the installation shall be carried out and comply strictly by BS 326 : 1965.
- (7) The zone of protection of a single vertical conductor shall be taken as the cone with its apex at the highest point of the conductor and with a base radius equal to the height.
- (8) All joints and bonds shall be adequately protected against ingress of moisture and consequent corrosion. The joints shall be tinned, soldered, brazed or double riveted . Bitumen impregnated jute or cotton tape shall be wrapped round all underground joints to guard against corrosion.
- (9) An earth termination shall be connected to each down conductor, each of these earth terminations shall have a resistance to earth not exceeding the product given by 10 ohms times the number of earth terminations to be provided.

- (10) The whole of the lightning protection system shall have a combined resistance to earth not exceeding 10 ohms before any bonding has been effected to metal in or on a structure or to services below ground . More than one electrode may be used if the required earth resistance is not achieved .
- (11) When rods are used, these shall be driven into ground to a depth of at least 2.5 meters . All the strips used for earthing shall be buried in at least 45 cm deep trenches, is straight or parallel or in radial from .
- (12) Earthing system used for lightning protection shall be independent of any other earthing system.
- (13) The entire lightning system shall be installed tested and commissioned as per BS CP 326: 1965.
- (14) Any other approved lightning protection system, or according to the drawing and bill of quantities.

F24.4 Fire Alarm System

F24.4.1 General

- (1) An automatic fire alarm system, the purpose of which is to detect and announce fire within a building equipped with such a system, consists of detectors, cable network which connects these to a control board containing necessary arrangements for indication of fire (alarm)and fault signals as well as arrangements for control and local alarm signal instrument. Furthermore power supply equipment is included in the fire alarm system.
- (2) The control board shall be constructed in such a way that the alarm signal automatically can be transferred, via a constantly controlled line, to a place from which the fire brigade or a remote manned centre is called.
- (3) The equipment transferring the alarm to a remote manned centre shall be controllable at all times and automatic.
- (4) An automatic fire alarm system shall, in order to fulfill reasonable safety requirements, be supervised by means of control current operation or similar.
- (5) Furthermore the system shall contain devices which indicate faults within the installation and such signals shall also be transferred to the alarm centre or other control centre . Alarm and fault signals shall be indicated in different ways.
- (6) An automatic fire alarm system shall, with the exception of arrangements for earth indicating devices, be completely insulated from earth. Thus, earth must not be used as return for any circuit.
- (7) The earth connection should, as a rule be connected to an incoming water pipe. The position of the earth connection shall be noted on the orientation plans or in the service instructions.
- (8) A fire alarm system, or parts of installations of different types and manufacturers must not be connected if the working safety of the system is then decreased .
- (9) The materials, of which the design and technical quality is of great importance for the function of the system and its length of service, shall be approved by the consultant. This demand mainly concerns the control board, detectors, alarm push buttons and charging equipment. The equipment for transmission of the alarm to the control board must also be of approved type.

- (10) Connection of detector loops to the central unit and adjustment of the system must be carried out by an authorized contractor.
- (11) The entire system shall comply with the latest addition of BS codes of practice cp 1019.
- (12) The entire fire alarm system shall be of the latest design. The whole system shall be tested and commissioned by the contractor at the completion works and project as a whole.

F24.4.2 Detectors

There are two types of detectors to be used, rate-of-rise/fixed heat temperature and smoke detectors. The allocation of detectors as shown in the drawings and should have the following specifications.

- (1) Rate- of- rise/ fixed heat detector (dual-rate of rise and maximum temperature): is a device which initiates an alarm when the temperature of ambient air rises at a rate exceeding one degree centigrade per minute or when the ambient temperature reaches 57 degrees centigrade. The upper limit of operating temperature should be taken as 100 degrees centigrade, and protected features surface per detector as 40m² for ceiling heights up to 9m.
- (2) Smoke detector :- Either one of the two types of smoke detectors, ionization smoke detectors and photo electrical smoke detectors should be used depending on the function of the protected area, and it should be of the type to give the optimum possible protection in accordance with the manufacturer's recommendation . These two types of detectors should have the following features:-
 - (a) Surveillance area per detector shall be at least 100m².
 - (b) Compensates for brief, dense clouds of smoke not caused by fires as a result of delayed alarm evaluation.
 - (c) Characterized by a universal response behavior to light, dark and invisible smoke .
 - (d) Three levels of response sensitivity.
 - (e) The upper limit of operating temperature shall be at least 80 degrees centigrade.

For all types of detectors, the following rules apply:

- (1) A detector should be professionally and expediently arranged. It should be satisfactorily resistant to normal changes of temperature, moisture, corrosion, dust and other pollutions. It also must resist mechanical strain such as vibrations, shaking and influence of eg. insects. Detectors in general should be of suitable design in the matter of installation.
- (2) In localities where the detector might be exposed to abnormal temperatures, corrosive substances, dust...etc, the detector must be of suitable design.
- (3) The detector should be lastingly labeled with the name of the manufacturer or dealer's imprint, type and year of manufacture. The rate - of - rise temperature detectors should be labeled with the rated release temperature in degrees centigrade.

- (4) If possible the labeling should be affixed on the base in such a way that it is visible when the detector is installed, if the detector's sensitive organs are exchangeable, year of manufacture should be labeled on the exchangeable part.
- (5) The releasing temperature should be marked, partially on the base and partially by colour marking according to a code on the contact springs or corresponding organ. If the contact springs are exchangeable, the base should also be colour marked.
- (6) Solid state electronic circuits.
- (7) Provided with an easily visible LED as an alarm indicator.
- (8) Protected against spurious alarms.
- (9) Designed for an easy - to – install 2- wire system.
- (10) Provided with a vibration – resistant rotary locking facility.
- (11) Provided with corrosion- free contacts.
- (12) Both types of detectors shall be of the self resetting design.
- (13) Both types of detectors shall be suitable for fixing in voids, surface mounted or flush mounted with false ceilings depending on the area of fixing.
- (14) It shall be possible to replace any detector without tampering with the wiring system.

F24.4.3 Break Glass Call Points

The allocation of break-glass call points is shown in the drawings and shall have the following features:

- (1) Surface or flush mounting.
- (2) Key operated test facility.
- (3) Integral LED test indicator.
- (4) No hammer is required.
- (5) Flameproof call point.
- (6) Weatherproof call point for external use.

F24.4.4 Local Alarm Signal Devices (Sounders)

The allocation of sounders is shown in the drawings and should have the following specifications:

- (1) Sounders should be arranged for the purpose they are serving and of reliable design.
- (2) If the number of these signaling devices exceeds five they should be divided into separately fused groups. By using sufficiently sensitive fuses, it is avoided that faults in the cable network for the local alarm devices influence the system in general.
- (3) The signaling devices shall be marked with the text fire alarm in both Arabic and English languages and shall, if necessary, contain information as to the measures to be taken.

- (4) The signaling devices should provide 75dBA of average sound level and 5dBA above the normal background noise level in each floor.
- (5) The signaling devices should be of siren type with output at least 87 dBA at there meters distance for 50 hours continuously rating.

F24.4.5 Cable Network

The fire alarm system cable network shall fulfill the demands in valid B.S. standards or other equivalent. If a standard cable cannot be used, another type may be used after special permission from consultant. Further, the following regulations should be applied

- (1) In group lines (loops) no joints may exist after the distribution blocks except in the detectors. All cables shall be run in such a manner that they are protected from external damage. Cable runs for high voltage current may be used only if the total length of the cables is run in conduits.
- (2) The cables must withstand the highest normal temperature at location.
- (3) The cable installation for group lines (loops) must be performed so that flash-over between lines from different loops, or between out-and incoming branches of the same loop, is unlikely to happen without in connection with earth fault, where earth fault indication shall be received if such a fault may cause a system break-down. Where earth fault indication cannot be received, as at the gathering of several group cables into a common feed cable, the conductors should be individually screened so that flashover is likely to cause simultaneous earth fault whereby the fault is indicated.
- (4) At a connection point between open wire line (overhead line) and indoor cable an excess voltage protection device of reliable construction should be installed. For self supporting insulated overhead lines with hanging detectors two –wire cable of sufficient strength and with a minimum dimension of 2x0.75 mm² shall be used.

F24.4.6 Control Board

A control board with a zones control unit is required. Separate signaling devices for alarm and fault signals shall be located at the control board. The control boards should have the following specifications:

- (1) The measured values transmitted by detectors are analyzed by the control unit. According to this analysis, the system should be capable of discriminating between area fire technical faults and environmental influences.
- (2) The control board should be mounted in a locker. Incoming alarm from detectors should automatically affect local alarm signal devices, mounted near the control unit or elsewhere within the building, optical signals should simultaneously indicate both that fire has occurred and within a group of detectors or from which sub central alarm is transmitted. To enable a quick identification of the alarm-initiating loop, these optical signals should be arranged in rows according to the numbering of the loops, together with a key for each loop. This key is essential for switching off (by-pass) the loop after and for testing the loop. It should be possible to equip the control unit with necessary arrangements for automatic transfer of alarm signals to the remote manned centre.

- (3) Circuits transferring an alarm to the remote manned centre must as far as possible be continuously controlled.
- (4) The control board should be equipped with a measuring instrument which indicates the total control current and the voltage of the power supply.
- (5) If a failing optical signal means that the fire alarm system is in such a condition that an alarm is not making signals on the local alarm signal equipment or is not being transferred to the remote manned centre, the optical signal must have two lamps connected in parallel. To indicate the group within which the alarm is indicated, double parallel- connected lamps or other devices of equivalent safety shall be used.
- (6) The alarm is to be "locked" in the control board so that it remains even if the detector signal causing the alarm ceases. The alarm shall not cease until manual resetting has been carried out in the control board and the section has been switched off. An optical signal should then indicate that the alarm section has been switched off.
- (7) Independent of the alarming section, a signal from a detector in another section must be able reach the control board.
- (8) When connecting a cable for alarm and fault signaling equipment to the control board, each cable shall be provided with a fuse or a protection resistor. When the fuse is blown, an indication (optical or acoustical) should be received at the control board. Connection of an extension board is allowed under identical conditions.
- (9) Faults occurring in detectors, cable network and batteries as well as in the control board should, to greatest possible extent, be automatically indicated in the control board. Fault indicating signals must be transmitted to the remote manned centre through a fault indicating mechanism or by some other dependable means.
- (10) The following faults should with satisfactory safety margin be acoustically indicated both in the control board as well as in the remote manned centre and be indicated by an optical fault signal in the control board:
 - (a) Earth fault or leakage at any point in the system must automatically be acoustically or optically indicated by means of a relay connected between earth and battery or by some other dependable means. The current that indicates earth fault should be negligible compared to the normal current in the circuits and must not disturb the systems normal operation in idle alarming position . An acoustical signal, caused by earth fault must be able to be switched off. An optical signal, however, shall indicate the remaining fault.
 - (b) Voltage fault of a magnitude that jeopardizes the normal function of the system. Mains voltage failure requires only optical indication and should not be indicated in the control board. If the voltage in a battery system drops below a certain value this should automatically be indicated. The value should be set so that normal function of the system is ensured with generous margins. In addition, other faults should automatically be indicated in cases where they may prevent an alarm from being initiated.
- (11) Automatically received signals must always be followed by acoustical signals in order to be noticed.

- (12) A faulty section should by means of a switch be disconnected without disturbing the function of other alarm sections.
- (13) The system shall comprise devices for test of the control board components and signaling devices and their functions for alarm and fault conditions in the alarm section. Instruction for this test is to be delivered with the system and should be kept at the control board. Equipment transmitting alarm and fault signals must not be disconnectable from the system without acoustical and optical signals being initiated in the control board.
- (14) The equipment prescribed for indication of earth fault in the system must be able to be checked by simple means.
- (15) Local alarm signal devices should be checked separately from the control board. The control board must, however connect the alarm signal devices automatically whether alarm is initiated from a detector or a call point.
- (16) Local alarm signal devices must also be able to be disconnected at the control board so that testing of a call point or of group of detectors can be carried out without causing local alarm. As long as this disconnection remains, a lamp designated for this purpose should indicate the disconnection in the control board.
- (17) All other system changes or temporary disconnection of a circuit must be indicated in the control board by a permanent optical signal.

F24.4.7 Power Supply

- (1) A fire alarm system which normally operates from the mains supply should automatically receive power from a battery at mains voltage failure. The battery must be capable of maintaining the system for at least three days.
- (2) The mains fuse in the fuse box shall be marked red.
- (3) The rectifier equipment shall be dimensioned so that it can power feed a faultless system for sufficient transmission of fault and alarm signals at battery failure.
- (4) A rectifier must be equipped with a reliable device for automatic voltage regulation on the battery side and as a rule it should be connected to a separate mains fuse.
- (5) Battery and rectifier being used as a power source for an automatic fire alarm system must not be used without special permission for other purposes.

F25 HVAC SYSTEM FOR NON-PROCESS BUILDING

F25.1 General

Install new and complete heating, ventilation and air-conditioning systems. Work will include all evaporator units, condensing units, electric heaters, grills, ventilation and exhaust fans, evaporator air cooler, piping connections, electrical connections and all necessary accessories to make each unit works properly according to standard. All equipment are to be installed as recommended by the manufacturer, using all accessory equipment available from the manufacturer for supports, controls, etc. to make a complete air-conditioning system.

F25.2 Split Air Conditioning System

The system shall consist of outdoor air-cooled condensing unit and indoor evaporating unit. Both indoor and outdoor units should be fitted with hydrophilic aluminum fins for improved performance. Unit pipes should be made of a newly shaped inner groove copper, which enables refrigerant to flow through more effectively, thus improving heat exchange efficiency and reducing power consumptions.

All suction and liquid lines that connect the two units should be properly covered. Wooder's cover while the outside lines should be well weather protected should nicely hide inside lines.

Evaporating units EU-1 and EU-2 should be wall mounted type, while evaporating units EU-3 should be free standing types as shown in drawings. The wall mount indoor unit should be compact, stylish design, high energy efficiency and whisper quiet operation. The unit should be reverse cycle type (cooling and heating) with active carbon and dust filter. The condensing unit should be quiet operation, compact, pre-charged copper pipe kits and with anti rust cabinet made from electrolytic zinc steel sheet and anti-rust coated components.

Split unit should be designed for a high temperature performance and the numbers and capacities are presented in the bill of quantity while the installation locations and specifications are presented as shown on the drawings. Electrical heat suction shall be installed in the unit and served by the same power source as the rest of the unit. Only one power feed shall be required for the unit. The unit should be approved quality.

F25.3 Evaporator Air Cooler

The standard housing for unit shall include wet and dry sections and constructed from stainless steel, grade 304. Metal gauge (thickness) generally being 18 or 16 gauge. Housing construction meets SMACANA standards, or other equivalent.

The blower should be centrifugal type backward inclined for high static pressure applications, double width, double intake as well as a flexible connection to the cabinet to allow for movement of the blower and motor. The motor is open face drip proof mounted on an adjustable mount. The wet section includes a float valve and recirculating pump as well as distribution piping.

A galvanized steel "C" channel type frame around the perimeter of the cooler and crosswise under the wet section and blower and as otherwise required to fully support the unit should be provided. The sizes and numbers are shown as a schedule in the drawing. The unit should be connected to the main duct through a flexible connection. The unit should be approved quality.

F25.4 Exhaust Fan

Install exhaust fan of highly efficient axial extract fans suitable for direct ventilation to the outside. Fans shall be provided with automatic louver shutter, which will be inter locked electrically with the fan. Fan shall be supplied with pressed steel mounted rings with at least (3) points fixing.

The motor and impeller shall be carried off the ring by means of arms fitted with resistant suspension. All impellers shall factory balanced blade assembly. Motor shall

be rated for continuous operation in ambient temperature up to 55°C. Motor shall be totally enclosed type having a power factor not less than 0.85.

Motor shall be specially treated for weatherproofing. Easy to remove front cover, shutters and impeller for cleaning. Fan sizes, specification and numbers are shown as a schedule in the drawings. All types should be approved quality.

F25.5 Electric Heater

Electric Heater consists of approved quality thermal metallic wires with coil and a thermal reflector. The heater should be provided with mesh metallic protector and off/on rope. The electric heater should be properly fixed in a wall (2) meters below the ceiling. The specifications of the electric heater are shown as a schedule in the drawings. The unit should be approved quality.

F25.6 Supply Air Register

Supply air register shall be of the double deflections type with adjustable horizontal face bars, vertical rear bars, complete with opposed damper and aluminum construction. Register shall have a soft, continuous rubber gasket between the periphery of the register and the building surface to which it is mounted. The register should be fixed properly with screws on a wood frame as showing in drawing.

F25.7 Ceiling Fan

Ceiling fan should be provided with approved quality of speed regulator. The fan should be properly fixed in ceiling with all electrical connections and necessary parts to make the fan works properly.

