

سلطة إقليم البترا التنموي السياحي

PETRA DEVELOPMENT AND TOURISM REGION AUTHORITY



## مشروع التطوير الحضري و السياحي لوسط مدينة وادي موسى



### المجلد الثاني المواصفات الفنية

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# **GENERAL SPECIFICATIONS**

PART 1 – GENERAL SPECIFICATION

GOVERNMENT PUBLISHED SPECIFICATIONS, REGULATIONS,  
NOTICES AND CIRCULARS

- A. The Works shall be executed and measured in accordance with the following Government specifications, methods of measurements, price inclusions, regulations, notices and circulars:
- (a) Specifications for Construction of Buildings for the Kingdom of Jordan issued by the Ministry of Public Works and Housing 1996.  
  
Volume One : Civil and Architectural Works  
Volume Two : Mechanical Works  
Volume Three : Electrical Works
  - (b) Specifications for Highway and Bridge Construction, 1991, issued by the Ministry of Public Works and Housing.
  - (c) General Technical Specification for sewerage works and for water mains distribution systems issued by the Ministry of Water and Irrigation / Water Authority (Latest Edition).
  - (d) Jordan Standard Specifications.
- B. The Contract shall be deemed to have his own copies and provide the site of the required specifications, standards, regulations, notice and circulars given at (a) and (d) above.
- C. In the case of any ambiguity or discrepancy, the provisions of the Project Particular Specification shall prevail over the provisions of the Government Published specifications.

END OF SECTION GS

**CIVIL & ARCHITECTURAL**

**Foam Concrete**

Foam concrete shall be produced by mixing a foaming emulsion with ordinary Portland cement and water in a purpose designed foamed mortar mixer. The density of the screed shall not be less than 650kg/m<sup>3</sup>.

The foaming emulsion shall be obtained from a specialist manufacturer approved by the Engineer. The mortar mixer shall be of a type recommended by the specialist manufacturer. All mixing and laying of foam concrete shall conform to the manufacturer's written instructions to thicknesses as indicated on the drawings with a minimum thickness of 50mm.

**APP Waterproofing Membrane**

The waterproofing membrane for protection of concrete roofs shall be mineral chipping faced membrane 4mm thick, reinforced with 180gm/m<sup>2</sup> of non woven polyester inlay and modified bituminous compound presenting high thermal stability, plasticity and flexibility characteristics as detailed on drawings and as specified in this Section. The thickness of the membrane shall be 4 mm as specified and indicated on drawings.

The typical characteristics of a 4mm thick membrane when tested according to ASTM D 5147 shall be as follows:

Tests	Unit	Required Val.	Tolerance
Thickness	mm	4	± 5%
Aeric Mass	Kg/m	4.6	±10%
Tensile strength; Long Tranv	N/5 cm N/5 cm	800 650	±20% ±20%
Lap joint strength; Long Tranv	N/5 cm N/5 cm	900 700	±20% ±20%
Elongation at break; Long Tranv	% %	35 40	±15% ±15%
Cold Bending	°C	-5 <sup>0</sup>	≤ -5
Form Stability	°C	100	≥100
Water pressure resistance (DIN 16935)	KPa	No leakage at 1000 mm water head/24 hrs.	≤ 1000
Softening point (ASTM D36)	°C	150	≤150
Down penetration 25 <sup>0</sup> C (ASTM D5)	dmm	25	±2

### **POLYETHYLENE SHEET**

Polyethylene sheets 250 microns thick shall be provided to areas as indicated on the drawings either in transparent or black colour to gauges shown therein. Polyethylene sheets shall be manufactured from 100% prime first grade quality resins to BS 6515:1984. Materials manufactured from recycled, off spec. or waste materials shall not be accepted. The polyethylene sheet shall exhibit all the characteristics of BS 6515:1984 and the Contractor shall produce necessary test certificates to the Engineer to prove the same. Overlaps shall not be less than 100mm and shall be sealed together using an approved adhesive or tape. The material shall be supplied, stored and installed in accordance with the manufacturers written instructions.

### **Elastomeric Waterproof Paint**

Elastomeric waterproofing paint shall be comprised of two components system; weather coat risen (Acrylic base) and weather coat powder (cement base).

#### **Technical Data**

Binders: Hydraulic (Weather coat powder) and Organic (Weather coat Risen)  
Specific gravity: 1.8  
Fillet: Crushed precisely graded fillers (weather powder)

#### **Application:**

- a- Apply fist coat using brush, roller or spray, and allowing 3 hours between coats to dry
- b- The two coats shall be applied in accordance to manufacturer's and Engineer's instructions
- c- All surfaces to be painted should be sound; clean and dry

### **STONECOAT**

Stone coat shall be used for reducing moisture ingress (water repellent) of natural stone at facades meanwhile allows stone to breath. Coat shall be transparent and silicone resin based impregnation. Coat shall be the blend of toughened resins and natural pigments.

Physical Properties:

Base:	Silicone resin
Appearance:	Clear
Solvent:	Hydrocarbon
Specific gravity:	0.97at 20 °C
Flashing Point:	> 40 °C

#### **Surface preparations**

1. All surfaces must be free from dust, dirt, salts, oil, grease and foreign materials
2. Protect all adjacent surfaces not to be coated.
3. All cracks, chips, voids and damages should be repaired with filler prior coating.

#### **Applications**

1. Protect adjacent areas not to be coated.
2. Application shall be either by spraying or brushing in 2 coats.



**Stone Coating Fountain tiling (treatment sealer).**

Natural look water based sealer to provide maximum stain protection for natural stone.  
Apply two coats, 0.125 L/m<sup>2</sup>

Physical & Chemical Properties:

Physical description & color: Clear straw colored liquid  
Odor: Slight solvent odor  
Boiling point: Approximately 100 C at 100kPa  
Volatiles: Water component + VOC (which is 47g/L)  
Vapour pressure: 2.37kPa at 20 C at 20 C (water vapour pressure)  
Specific Gravity: 1.0 approx.  
Water Solubility: Completely soluble in water

**Polyurethane Coating (Wood treatment paint), External**

Polyurethane coating consists of 100% acrylic paint water base to provide wood protection from cracking, warping, splitting, and UV-damage and colour stability.  
Minimum 2 coats required and coverage rate per manufacturers instructions  
Prepare the surface with liquid concentrate primer and perform a trial brush-out in several areas to ensure the desired color is achieved

Physical Properties / Technical Data

Solids by Weight: 38 – 40 %  
Solids by Volume: 30.6 -- 32.6 %  
Viscosity Range (Stormer Viscometer at 77° F (25° C)): 80 – 90 KU (Tinted)  
V.O.C. Content: Max. 0.8 lbs./gal. 100 g/l Meets federal and all state V.O.C. requirements.  
Flash Point: >200°F , >93.3°C  
Warranty 10 years minimum

**Glass**

**Shops Entrance**

Glass Type used for external facades		Double glazing consists of Outer Panel: 6mm clear tempered glass Air Space: 12mm Inner Panel: 6mm clear tempered glass
Visible Light transmittance	%	57
'U' Value "summer"	W/m <sup>2</sup> °C	1.9
Shading Coefficient		0.53

**Spider System glass Elevation**

Glass Type used for external facades		Double glazing consists of Outer Panel: 10mm clear laminated glass Air Space: 16mm Inner Panel: 8mm clear laminated glass
Visible Light transmittance	%	57
'U' Value "summer"	W/m <sup>2</sup> °C	1.9
Shading Coefficient		0.53

# **ROAD WORKS**

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## **PART (2): EARTHWORKS**

### **SECTION 2.01 CLEARING & GRUBBING**

#### **Sub-Section 2.01.1 SCOPE**

Add and amend as follows:-

No clearing and grubbing operations shall commence before the surveys of the existing ground profiles have been carried out jointly with the Employer and the Engineer.

### **SECTION 2.02 REMOVAL OF OBSTRUCTIONS AND UTILITIES**

#### **Sub-Section 2.02.1 SCOPE**

Add and amend as follows:

1. It is the Contractor's responsibility to liaison and cooperate with the Official Authorities for the removal of any properties which fall within the limits for the right-of-way (ROW). The obstructions shall include, but not limited to culverts, retaining walls, wingwalls, grouted riprap ditches and slopes, fences, Gates, water structures, walls, buildings ... etc.
2. Existing utilities and obstructions shown on the drawings are given for guidance only, the Contractor should get familiar with all obstructions and utilities by site visits and coordination with private and public utility owners.
3. Any additional costs or delay to difficulty of working or to any other reason arising from the work described in this section, shall be borne by the contractor.

#### **Sub-Section 2.02.3 MEASUREMENT**

Add and amend as follows :

- Unless shown as Pay items in the Bills of Quantities the removal of all obstructions and utilities. (Except for utilities realignment described in 1.03.6) shall not be measured for direct payment, but shall be considered as subsidiary works the costs of which will be deemed to be included in the Contract prices for Pay Items.
- The Bills of Quantities contain a Provisional sum for "Compensation of utility owners of fences, gates, walls and buildings" this sum will be used by the employer to reimburse or compensate the above utility owners for the damage caused to their utilities.
- Expenses, overheads and profit associated with the above pay item shall be paid as percentage to the actual payment made as shown in the Bills of Quantities.

- Amend Pay items to read as shown in the Bills of Quantities under “Scope and Control of Works” in Bill No. (1).

## **SECTION 2.03 HIGHWAY EXCAVATION**

### **Sub-Section 2.03.2 CONSTRUCTION**

Add and amend as follows :

Prior to any excavation work commencing, the Contractor shall conduct at his expense a comprehensive series of trial borings or trial pits along the highway reserve to obtain samples and carry out all testing necessary to determine the locations and quantities of material available for use in the selected unclassified excavation meeting the requirements of Article 2.06 for embankment construction.

The details of all borings or pits, the characteristics of all materials encountered and the results of all tests shall be submitted to the Engineer before any excavation work may commence. Based on this information the Contractor shall submit to the Engineer for approval his proposals for his methods and program for winning the required quantity of each material and handing it into the completed works.

The Contractor shall stockpile in locations all to the approval of the Engineer. He shall rework such stockpiled material into the works in accordance with his approved program submitted under clause 14 of the General Conditions of Contract. No separate measurement or payment will be made for this work, which is deemed to be included in the rates and prices for the item of work included in the Bill of Quantities.

### **Sub-Section 2.03.3 MEASUREMENT**

Replace this Sub-Section by:

1. All excavated material (below top of subgrade) of whatever type shall be measured as “unclassified” which shall be deemed to include all materials encountered of any nature, including silts, clays, sand, gravel and granular materials, fractured, jointed and solid rock, unsuitable material, existing pavements, and curbs.
2. Highway Excavation (including side ditches, furrow ditches, channels, wadi relocation, grading and trimming certain areas, steps for wadi stabilization, steps near stilling basins, and benching) shall be measured by cu.m. of material excavated, hauled away and either wasted, stockpiled, or deposited on or in vicinity of highway embankment areas, completed and accepted. Measurements shall be of volumes computed from the cross sections shown on the Drawings and the original ground elevations taken jointly by the Engineer, the Employer and the Contractor before clearing and grubbing operations. These excavations shall be referred to as Unclassified Highway Excavation.
3. Excavation of Unstable Material (from areas outside the ROW) where indicated or directed shall be measured as Unclassified Highway Excavation.

Measurements shall be volumes computed from surveyed cross sections of original and final ground elevations.

4. Excavation required for the drainage of excavation areas, obliteration of disused roadways, and other ancillary excavation Works shall not be measured for direct payment, but shall be considered as subsidiary Works the costs of which will be deemed to be included in the Contract prices for Pay Items.
5. Cutting for benching in fill areas, if authorized and required as specified under sub-clause 3.3 of sub-section 2.06.3, shall be measured, and included under the same pay item "Unclassified Highway Excavation".

<u>Pay Item</u>	<u>Unit of Measurement</u>
(1) Unclassified Highway Excavation	Cubic meter (cu.m)

## **SECTION 2.07 SUBGRADE CONSTRUCTION AND TOPPING**

### **Sub-Section 2.07.2 MATERIALS**

Add the following, at the end of Clause No. (1) to read as follows:

And if tested after compaction a tolerance of 3% is allowed in upper limit for percentage of material passing sieve 200.

Add Clause No. (4)

4. Topping material shall be prepared for tests in accordance with AASHTO T-146.

### **Sub-Section 2.07.4 MEASUREMENT**

Delete Clause No. (2), and replace by :

2. Subgrade layer or layers in approved insitu material shall be scarified to a minimum depth of 200 mm including removal of undesirable matter, compacted, completed and accepted. This work shall not be measured for direct payment but shall be considered as subsidiary Works the cost of which will be deemed to be included in the Contract Prices for Pay Items.

Delete the Pay Items and replace by: -

<u>Pay Item</u>	<u>Unit of Measurement</u>
(1) Topping material	Cubic meter (cu.m)

**PART (3): SUB-BASE AND BASE COURSES**

**SECTION 3.01 MATERIALS**

**Sub-Section 3.01.3 GRANULAR MATERIALS FOR SUB-BASE**

Modify as follows:

- In Clause 3, second line, delete “B or”
- Delete Table 3.1 and substitute by the following :

**Table 3.1 – Gradation For Granular Material**

<b>Sieve Designation (Square Openings)</b>	<b>Class A</b>
63 mm (2-½ in.)	100
50 mm (2 in.)	80-100
37.5 mm (1- ½ in.)	70-95
25 mm (1 in.)	55-90
12.5 mm (½ in.)	45 –75
4.75 mm (No.4)	30 – 60
2.00 mm (No. 10)	22 - 48
0.425 mm (No. 40)	10 - 30
0.075 mm (No. 200) Brfore Compaction	5 – 12
0.075 mm (No. 200) After Compaction	Max 15%

- Add to the following at the end of table 3.1:  

“The amount of fraction of material passing the No. 200 mesh sieve shall not exceed 67 % of the fraction passing the No. 40 sieve”.
- Add the following at the end of Clause 4:  

The specified sand equivalent value corresponds to the value obtained in accordance with AASHTO T176 (Dry Method) for the material in dry condition.
- In Clause 5, amend the following:
  - a) In the first line, delete “ 45%” and replace by “40%”
  - b) Delete the forth and fifth lines and replace by the following:

The ratio of wear loss =  $\frac{\text{Abrasion after 100 Rev.}}{\text{Abrasion after 500 Rev.}}$  should not be more than 0.25

- In Clause 8, add the following to the end of paragraph:  

“as determined by B.S.12. Otherwise, for granular material, non plastic condition may be accepted provided that the layer edges are confined, covered, or protected.”

- Add the following Clause:
- 10. Chert content (determined as percentage by weight insoluble in hydrochloric acid) for sub-base material shall be within reasonable limits, which will not affect the formation of intact cohesive surface.

**3.01.4 AGGREGATE FOR BASE COURSES**

- In Clause 5, delete “or Class B “from the second line and replace Table 3.2 by the following table:

Sieve Designation (Square Openings)	Class A
50 mm (2 in.)	
37.5 mm (1- ½ in.)	100
25 mm (1 in.)	75 – 100
19.0 mm (¾ in.)	60 – 90
12.5 mm (½ in.)	45 – 80
9.5 mm (3/8 in.)	40 – 70
4.75 mm (No.4)	30 – 55
2.00 mm (No. 10)	20 – 40
0.425 mm (No. 40)	8 – 20
0.075 mm (No. 200) Before compaction	5 – 10
0.075 mm (No. 200) After compaction	Max 13%

“The amount of fraction of material passing the No. 200 mesh sieve shall not exceed 67% of the fraction passing the No. 40 sieve”.

- Add the following at the end of Clause 5:  
The specified sand equivalent value corresponds to the value obtained in accordance with AASHTO T176 (Dry Method) for the material in dry condition.
- In Clause 6, amend the following:
  - a. In the first line, delete (45%), and replace by (40%).
  - b. Delete the third and the fourth lines and replace by the following:

The ratio of wear loss = 
$$\frac{\text{Abrasion after 100 Rev.}}{\text{Abrasion after 500 Rev.}}$$
 should not be more than 0.25

- In Clause 9, add the following to the end of paragraph:  
“as determined by B.S.12. Otherwise, for granular material, non plastic condition may be accepted provided that the layer edges are confined, covered, or protected.”
- Add the following Clauses:



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11. Of the particles which are retained on a 3/8in (9.5mm) sieve, at least 75% shall have two or more fractured faces.
10. Chert content (determined as percentage by weight insoluble in hydrochloric acid) for sub-base material shall be within reasonable limits, which will not affect the formation of intact cohesive surface.

## **PART (4): BITUMINOUS CONSTRUCTION**

### **SECTION 4.01 MATERIALS**

#### **Sub-Section 4.01.3 AGGREGATES FOR BITUMINOUS PAVING MIXES**

Table 4.1

Delete Table 4.1 and replace by the following:

Table 4.1: Gradation of Aggregates for Bituminous Mixes

<b>Sieve Designation</b>	<b>Binder Course</b>	<b>Wearing Course</b>
1 1/2" (37.5 mm)	-	-
1" (25.0 mm)	100	100
3/4" (19.0 mm)	70 - 100	90 - 100
1/2" (12.5 mm)	53 - 90	71 - 90
3/8" (9.5 mm)	40 - 80	56 - 80
No. 4 (4.75 mm)	30 - 56	35 - 56
No. 8 (2.36 mm)	23 - 38	23 - 38
No. 20 (1.18 mm)	13 - 27	13 - 27
No. 50 (0.300 mm)	5 - 17	5 - 17
No. 80 (0.150 mm)	4 - 14	4 - 14
No. 200 (0.075 mm)	2 - 8	2 - 8

### **SECTION 4.02 BITUMINOUS PRIME AND TACK COATS**

#### **Sub-Section 4.02.2 MATERIALS**

Add and amend as follows:

- 1) The grade of asphalt to be used for priming shall be MC-70 conforming with AASHTO M82 and as specified in the General Specifications.
- 2) The grade of asphalt to be used for tack coat shall be rapid-curing cut-back Asphalt RC-250 conforming with AASHTO M81 and as specified in the General Specifications.

#### **Sub-Section 4.02.5 APPLICATION PROCEDURES**

Add and amend as follows:

The Engineer's Representative will select the rate of application for the asphalt primer to be used within the limits stipulated in the general specifications.

## SECTION 4.03 BITUMINOUS COURSES

### Sub-Section 4.03.3 JOB MIXES AND PROJECT MIXES

Table 4.10

Delete Table 4.10 and replace by the following:

“Table 4.10: Maximum Variations of Project Mix from Approved Job Mix”

Sieve Designation (Square Opening)	Specified tolerances (%)
9.5 mm (3/8 in) and above	+ or - 5.0
4.75 mm (No. 4)	+ or - 4.0
2.36 mm (No. 8)	+ or - 3.0
1.18 mm (No. 16)	+ or - 3.0
0.60 mm (No. 30)	+ or - 3.0
0.30 mm (No. 50)	+ or - 3.0
0.15 mm (No. 100)	+ or - 3.0
0.075 mm (No. 200)	+ or - 1.0
Bitumen Content	+ or - 0.30
Temperature of mix on discharge	+ or - 5 c° of the specified mixing Temperature

Add the following new clauses:

13. The initial mix design shall be called the laboratory design mix. Only after full-scale mixing, laying and compaction trials have been successfully completed is the contractor to propose and the Engineer to approve the mix as the basis of the Job Mix formula.
14. As production of bituminous mix proceeds, and based upon the daily dry aggregate and the daily Marshall Specimens characteristics, the initial Job mix formula should be adjusted to meet the specifications requirements.
15. It is vital, and necessary to avoid variations in the Aggregates and bitumen properties so as to retain constant Job mix formula all the way through the Bituminous pavement construction.

However, at evidence of Mix properties variations, new Job Mix formula have to be established by the contractor and approved by the Engineer.

Variations in mix properties may result in lower stability value, excess of loss of stability percent, and variation by more than  $\pm 0.05$  in the bulk specific gravity of the Marshall specimens.

#### **Sub-Section 4.03.6 MIXING PROCEDURES**

Clause No. 6:

Add the following at end of clause 6:

"Mixing time shall be the minimum possible, consistent with the production of a homogeneous distribution of Aggregate particles and uniform coating with bitumen".

#### **Sub-Section 4.03.8 DELIVERY, SPREADING AND FINISHING**

Replace Clause 1.5 by:

1.5 The mix at delivery to the paver shall be not more than 10°C below discharge temperature at the mixing plant. The minimum temperature for the commencement of breakdown rolling is 130°C. The minimum acceptable delivery temperature may be lowered by the Engineer if the Contractor demonstrates that the minimum temperature at the start of breakdown rolling (i.e. 130°C) can be ensured. Mix loads of temperature less than 120°C shall not be accepted, and the load shall be disposed of and another load used. If there is consistent failure to meet the temperature requirement, the Engineer shall order paving operations to stop until suitable measures are taken by the Contractor to ensure that temperature requirements are met.

Add the following new clauses as follows:

- 1.7 Under any circumstances, no vibrating roller shall be used below 120°C. Finishing rolling is not allowed when the mix temperature has dropped to 90°C.
- 1.8 Reference density for determination of degree of compaction shall be the daily marshal density provided that the daily Marshall density shall not vary by more than  $\pm 0.05 \text{ g/cm}^3$  from the approval marshal design density.

Clause No. 5.7:

Amend the clause to read as follows:

"The minimum temperature of the mat at which rolling shall be allowed to start is 130°C.

Clause No. 5.11:

Amend the clause to read as follows:

"The initial or breakdown rolling shall be followed by intermediate rolling involving at least 3 coverage with pneumatic - tired rollers.

#### **Sub-Section 4.03.9 SAMPLING AND TESTING**

Clause No. 3:

Add the following at the end of clause (3):

"Bituminous cores should be taken at least 24 hours after laying, unless otherwise approved by the Engineer".

## **SECTION 4.05 BITUMINOUS BINDER AND WEARING COURSES**

### **Sub-Section 4.05.3 JOB MIX AND PROJECT MIX**

Table 4.15

Delete Table 4.15 and replace by:

"Table 4.15 Job Mix Requirements for Bituminous Binder and Wearing Courses

<b>Property</b>	<b>Binder Course</b>	<b>Wearing Course</b>
Marshall Stability at 60°C, Kg	900 (min.)	1000 (min.)
Flow (mms)	2 - 3.5	2 - 3.5
Voids in Mineral Aggregates (VMA)	13 (-1) (min.)	14 (-1) (min.)
Air Voids (%)	4 - 7	4 - 6
Stiffness (kg/mm)	500 (min.)	500 (min.)
* Loss of Stability	25 (max.)	25 (max.)

\* This test is carried out in accordance with AASHTO T 165 - 82."

### **Sub-Section 4.05.10 SURFACE TOLERANCES**

Clause No. 2:

Amend the clause to read as follows:

"The tolerance on elevations of the final bituminous wearing and binder course surfaces shall not be greater than 10 mm".

Clause No. 3:

Amend the clause to read as follows:

"When the finished wearing and binder course surfaces are tested with a 3 m long straight edge, placed parallel to, or at right angles to the centerline, the maximum deviation of the surface from the testing edge between any 2 contact points shall not exceed 3 mm for the wearing course and 4 mm for the binder course".

### **Sub-Section 4.05.12 MEASUREMENT**

Add the following :

Pay items shall be as shown in the Bill of Quantities.

## **SECTION 4.10 PAVEMENT REPAIRS AND TRENCH REINSTATEMENT WORKS**

### **Sub-Section 4.10.8 MEASUREMENT**

Delete the following:

Works prescribed in this Section shall not be measured for direct payment, but shall be considered as subsidiary works the cost of which will be deemed to be included in the Contract prices for Pay Items.

## **SECTION 4.11 – BITUMINOUS OVERLAY**

The bituminous overlay course(s) shall consist of wearing course and/or binder course conforming to part (4) “ Bituminous Construction” , of the Specifications.

### **1. Preparation of the existing surface**

The following preparatory steps shall be taken before starting the laying of the bituminous overlay:-

1-Existing Asphalt shall be milled, as shown on the DWG. To a depth of (40)mm using electronic sensor equipment (measured at both edges of the proposed new lanes). Milling width shall be as directed by the engineer.

2-Cracks repair:

3-Medium cracks (width of 3mm-19mm) shall be cleaned with broom and air and filled with rubber or other approved electrometric modified asphalt sealants conforming with ASTM D190 or AASHTO M-173. The sealant material is then sprinkled with dry sand.

4-Pot holes shall be cleaned out and patched as indicated in the drawings.

5-The existing surface shall be hatched, cleaned of all foreign material and broomed free of dust. In addition any loose, broken or shattered bituminous material along the edges of the existing surface shall be removed.

6-Manhole covers, catch basins, drop inlets...etc. shall be adjusted to fit the new surface grade.

7-All existing non relocated manholes and inlets top levels shall be raised to suit new overlay levels.

After the existing surface has been cleaned and prepared, a tack coat shall be applied as specified.

**2. Placing of overlay courses (Binder or Wearing):-**

The bituminous overlay shall be spread and finished in layers as shown on drawings and specifications.

**3. Measurement and Payment**

Overlay of bituminous course shall be measured by square meters of mix furnished, spread, compacted, completed and accepted. Measurements shall be of the areas and thickness as shown on the drawings and indicated in the Bill of Quantities.

Items 1-2 to 1-7 inclusive shall not be measured for direct payment but all costs shall be deemed to be included in the bid price for bituminous overlays.

Asphalt milling (as described on item 1.1) shall be measured by square meter.

<u>Pay Item</u>	<u>Unit of Measurement</u>
(1) Overlay 40mm wearing asphalt course	square meters (sq.m)
(2) Asphalt milling	square meters (sq.m)

## **PART (5): CONCRETE, STEEL & STRUCTURES**

### **SECTION 5.01 CONCRETE AND CONCRETE MIXES AND TESTING**

#### **Sub-Section 5.01.2 MATERIALS**

Add the following to 5.01.2.1:

Unless otherwise noted in the specification or instructed by the Engineer, sulfate resistant Portland cement (SRC) shall be used for non-reinforced concrete (blinding concrete) and ordinary Portland cement shall be used for reinforced Concrete.

#### **Sub-Section 5.01.4 CONCRETE STRENGTH REQUIREMENTS**

Add the following:

Unless otherwise shown on the Drawings and Bill of Quantities:

- a) Concrete Class 15 shall be used in all plain concrete, such as mass concrete, blinding ... etc. It should have characteristic compressive strength of 15 N/mm<sup>2</sup> for cube or 11.55 N/mm<sup>2</sup> for cylinder.
- b) Concrete Class 30 shall be used in all reinforced concrete as specified on the drawings for the relevant reinforced structures. It should have a characteristic compressive strength of 30 N/mm<sup>2</sup> for cube and 26.1 N/mm<sup>2</sup> for cylinder based on 28 days compressive strength.
- c) Concrete Class 45 shall be used in prestressed concrete. It should have a characteristic compressive strength of 45 N/mm<sup>2</sup> for cube and 36 N/mm<sup>2</sup> for cylinder based on 28 days compressive strength.

NB. - The minimum cement content should also satisfy the durability requirement as shown on table 5.5 A, table 5.5 B, table 5.5 C and table 5.6 of the General Specifications.

#### **Sub-Section 5.01.8 MEASUREMENT**

Add and amend to 5.01.8.2 the following:

Concrete shall be measured for different structural elements as shown in the Bill of Quantities.

Measurement and Payment shall be based upon different classes of concrete as mentioned in Pay Items irrespective of type of form and/or falsework and irrespective of class of surface finish.

Add the following to 5.01.8.4:



- 1) Where Pay Items for any items are not provided in the Bills of Quantities, the works prescribed in respect of such items or the items shown in the drawings shall not be measured for direct payment but shall be considered as subsidiary works the cost of which shall be deemed to be included in the Contract prices for Pay Items.
- 2) Backfill drains, shear key, induced contraction and expansion joints and any other items shown in the drawings shall not be measured for direct payment, but shall be considered as subsidiary to the concrete, the cost of which shall be deemed to be included in the Contract prices for pay items.
- 3) The expansion joint between existing and new culverts as shown in the drawings and the removal of the existing inlet or outlet concrete structures, if any, shall not be measured for direct payment, but shall be considered subsidiary to the concrete, the cost of which shall be deemed to be included in the Contract prices for pay items.
- 4) The removal of concrete sections, and the utilization of the existing concrete elements – if any – which involves the exposure of reinforcement to provide the required reinforcement lap length shall not be measured for direct payment, but shall be considered subsidiary to the concrete, the cost of which shall be deemed to be included in the Contract prices for pay items.
- 5) Inspection holes with service pipes, deflection and contraction joints used for concrete parapets, all types of joints (except the joints stated in 5.18.5), shear bars, threaded inserts sleeves, expanded polystyrene fillings, joint filler, tar paper, sealants, epoxy (mortar, resin or adhesive paint) including any associated items shown in the drawings shall be considered subsidiary to the concrete, the cost of which shall be deemed to be included in the Contract prices for pay items.
- 6) Precast concrete units, if used, for deck slabs casting, which includes concrete, reinforcement detailed design, casting, transportation, erection and handling shall be considered subsidiary to the concrete, the cost of which shall be deemed to be included in the contract prices for any items.

## **PART (8): INCIDENTAL CONSTRUCTION**

### **SECTION 8.01 CONCRETE CURBS, GUTTERS, SIDEWALKS AND PAVED MEDIANS**

#### **Sub-Section 8.01.1 SCOPE**

Add the following:

The work shall include the 10 cm concrete bed slab Class 25 used in the curb opening for roadway drainage as shown on the drawings.

The work shall include Precast Interlocking Tiles for road paving as shown on the drawings.

#### **Sub-Section 8.01.2 MATERIALS AND PRECAST MANUFACTURES**

Add the following to Sub-Clause 4.7:

The precast concrete curbs shall be tested in accordance to the Jordan Standard Specification (JSS) No. 479/94.

Add the following to Sub-Clause 4.8:

#### **4.8 Precast Interlocking Tiles Materials and Fabrication:**

##### **4.8.1 Materials**

##### **4.8.1.1 Interlock Pavers:**

- 1- Type: Interlock Pavers of 30 MPa, 28 day compressive strength.
- 2- Air Entrainment: 3% minimum, 5 % maximum.
- 3- Moisture Content: 7 percent.
- 4- Thickness: 80 mm thick.
- 5- Color and texture: Selected from manufacturer's standard range.
- 6- Shape: Selected from manufacturer's standard range.
- 7- Interlock Pavers Unit: shall conform to ASTM C936-82. Sizes and format as shown on the drawings with 60mm thickness unless otherwise indicated.

##### **4.8.1.2 Mix Design**

- Properties of Mix: Adjust design mix (mixes) as required to obtain the strength specified.
- 1- Compressive Strength: Minimum 300 Kg/Sq. cm Characteristic cube strength at 28 days.
  - 2- Slump: 75mm maximum.

##### **4.8.1.3 Sand for Setting Bed and Joint Filler: ASTM C144, clean fine sand.**

##### **4.8.2 FABRICATION**

##### **4.8.2.1 Interlock Pavers:**

- 1- Forming: Cast in formwork, to produce finish units of the dimensions shown, true to line, plane and dimensions.
- 2- Color and Finish: Maintain a uniformity of color and finish within the range established by the approved samples. Provide units with smooth, hard finish, on exposed surfaces, achieved by the use of steel trowelling, or other approved methods.
- 3- Curing: Cure units by steam or water (no curing compounds) for a sufficient length of time to permit handling without damage.
- 4- Cleaning: After removal of formwork and after concrete is thoroughly dry, clean the surfaces of units to remove all loose particles and foreign materials and protect unit from damage.

## **8. Bedding**

Add and amend as follows:

Bedding materials shall be as shown on the drawings. The materials shall conform to the relevant requirements of the specifications.

### **Sub-Section 8.01.3 CONSTRUCTION AND INSTALLATION**

Add the following to Sub-Clause 5.0:

#### **5.0 Precast Interlocking Tiles Preparation and Installation:**

##### **5.1 Precast Interlocking Tiles Preparation:**

###### **5.1.1 Interlock Pavers:**

- 1- Subgrade: Grade and compact the subgrade to the required elevation. Reduce high spots and raise low spots to grade with approved compacted materials and compaction to the required density comply with Section 02300 "Earthwork".
- 2- Setting Bed: Spread bedding sand, on compacted subgrade, and compact to the thickness shown to achieve an even, accurate surface, at proper elevation, for the pavers and blocks.

##### **5.2 Precast Interlocking Tiles Installation:**

###### **5.2.1 Interlock Pavers:**

- 1- Set the interlock pavers on the setting bed and work into place so as to provide total bearing of the setting bed, without voids under the pavers.
- 2- Set the interlock pavers in pattern shown with uniform open joints of the size shown. If joint width is not shown provide 5mm wide joints. Set tiles then level to required slope and level, using a wood or rubber hammer to tap surface or sides of tiles to place-in position. If not determined a suitable slope of paving surface is 30mm for each 3mt. (1% min. slope) to allow flowout of rain water.
- 3- Cut unit pavers with motor-driven masonry sand equipment to provide clean sharp, unchipped edges. Cut units to provide pattern indicated and to fit

adjoining work neatly. Use full units without cutting where possible. Hammer or any other means of cutting are not acceptable.

4- Filling Gaps

- a. Spray dry clean sand of not more than 3mm size, over paved area. Then sweep sand in all directions with a broom to allow sand to enter gaps between tiles.
- b. Spray paved area with water.
- c. After surface of tiles is dry, repeat steps 'a' and 'b' until gaps are filled.
- d. Do not use mortar to fill gaps between tiles.

**Sub-Section 8.01.4 MEASUREMENT**

- Amend the following to Clause No. (1):

Edge beam shall be measured as In Situ concrete curb.

- Amend Clause No. (2) To read as follows:

“In situ concrete paving, precast concrete tiling and concrete bed slab used in the curb opening shall be measured ... etc.”

- Add and amend the following to Clause No. (4):

- “Mortar, sand” is added to the first line.
- Bedding materials shall be measured and paid as part of the pavement layers according to the type of bedding material shown on the drawings.

Add Clause No. (7):

Precast Interlocking Tiles shall be measured by square meter furnished, constructed or installed, completed, and accepted. Price shall include bedding material.

- Amend the pay items to read as follows:

<u>Pay Item</u>	<u>Unit of Measurement</u>
1. Precast Concrete Curb (Curb stone)	Linear Meter (L.m)
3. Precast Interlocking Tiles	Square Meter (sq.m)
4. In Situ Concrete for bed slab in the curb opening	Square Meter (Sq.m)
5. In Situ Concrete Paving	Square Meter (Sq.m)
6. Precast Concrete Tiling	Square Meter (Sq.m)
7. Edge beam	Linear Meter (L.m)

## **SECTION 8.10 MAINTENANCE OF TRAFFIC AND DETOURS**

### **Sub-Section 8.10.2 MAINTENANCE AND PROTECTION OF TRAFFIC**

Add and amend as follows:

- The Contractor shall conform to the “Manual On Traffic Control At Road work Zones” of the Ministry of Public Works and Housing.

## **SECTION 8.11 HIGHWAY SIGNING**

### **Sub-Section 8.11.2 MATERIALS**

#### **1. Concrete**

Amend on follows:

- Concrete for sign supports footings shall be Class 25.

#### **3. Sign Supports**

Add and amend on follows:

- For rectangular shape signs with width equal or less than 2.5m, circular and rectangular signs, supports shall be 3 inch internal diameter weighing not less than 6.5 kg/l.m hot dip galvanized according to ASTM A123.
- For rectangular shape signs with width more than 2.5m, 4 inches internal diameter weighing not less than 7.5kg/l.m hot dip galvanized according to ASTM A123.
- All signs shall be of breakaway system.

#### **7. Sign Materials:**

Add and amend as follows:

- Steel sheet shall not be less than 1.5mm thick, hot-galvanized with a minimum of 250gm/m<sup>2</sup> on the two sides.

#### **8. Reflective Sheeting**

Add and amend as follows:

Reflective sheeting shall be high intensity prismatic type IV for all signs including the temporary traffic signs.

#### **Sub-Section 8.11.4 MEASUREMENT**

Delete sub-section 8.11.4 and substitute by the following:

1. New Small Signs (Triangular, Circular, Rectangular and Octagonal shape) shall be measured by number of sign installed in place and accepted (including sign posts construction and foundation).
2. Payment shall be made according to the different classes of signs at the contract unit rate including, but not limited to, erection, excavation, foundation, backfilling, compaction, materials, painting, frames, posts, bolts, fitting accessories, breakaway system and all other items necessary for the proper completion of the work.

Add and amend pay items to read as follows:

<u>Pay Item</u>	<u>Unit of Measurement</u>
1. Small Signs (Triangular shape, circular Shape Signs, Rectangular and Octagonal shape signs) (Area $\leq$ 1 Square meter)	Number (No.)

#### **SECTION 8.12 PAVEMENT MARKINGS FOR TRAFFIC**

##### **Sub-Section 8.12.1 SCOPE**

Add the following item:

- 1.3 Sprayed Thermoplastic, reflectorized paint (TRP) material shall be used for painted markings, lines and arrows in this Project.
- 1.4 Slip Proof Tempered Glass Reflecting Marker (SIG-14-sp) **Tiger Eye**, Siglite- (360 degree slip-proof and ultra-low glass road marking reflector) – white colour shall be used in this project as shown in the drawings.

##### **Sub-Section 8.12.3 APPLICATION AND INSTALLATION**

###### **5. Thermoplastic Reflectorized Paint (TRP) Application**

Add and amend as follows:

The minimum thickness of sprayed lines (white and yellow) shall be 2mm.

Add the following clause:

###### **8. Slip Proof Tempered Glass Reflecting Marker Installation**

- 8.1 Use the drilling machine to make a hole with diameter of 100mm and depth of 25mm (mark on the drilling machine or add a ring slot on the drilling bit to ensure certain depth of the hole drilled).
- 8.2 Use the bush tool to remove asphalt from middle of the hole (in case of cement road surface, use jackhammer to crush the cement).
- 8.3 Blow away the sandy soil and water in the hole with high-pressure air (or absorb water with sponge).
- 8.4 Use mold with fixed height to test if the depth of hole is suitable or not (otherwise modification must be made).
- 8.5 Place asphalt glue or epoxy resin into the hole  
(The asphalt glue is fast hardening and fast to work with; it influences traffic less with low cost, which is suitable for highway, large traffic flow or large amount of continuous installation. For loose works with less quantity, epoxy resin is used)
- 8.6 Place Tiger Eye into the hole and rotate for about 30°; finally, lightly knock the top of Tiger Eye with rubber hammer for smoothness and complete fixture.

#### **Sub-Section 8.12.5 MEASUREMENT**

Add and amend as follows:

1. Painted Pavement Lines and Painted Pavement Markings shall be measured net by linear meters and square meters or numbers as itemized in the Bill of Quantities of completed and accepted work including glass beads as per Specifications.
2. Payment shall be made for the amount of completed and accepted work as measured by linear meters, square meters and number at the relevant Contract unit price, which shall be full compensation for furnishing all materials, for all labour, equipment, glass beads and tools, supplies and all other items necessary for the proper completion of the work.
  - Pavement studs shall be measured by the number whether it has 1 or 2 reflective surfaces as shown on Drawings.

Delete pay items (1) to (9) and replace by the following:

<u>Pay Item</u>	<u>Unit of Measurement</u>
1. Painted Pavement Lines Marking (each class and width)	Linear Meter (L.m)
2. Painted Pavement Marking - for Pedestrian crossings, stop lines and Yield lines - (each class)	Square Meter (Sq.m)

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3.	Painted Pavement Markings for Hatching (each class)	Square Meter (Sq.m)
4.	Direction Arrows	Number (No.)
5.	Slip Proof Tempered Glass Reflecting Marker (Tiger Eye)	Number (No.)
6.	Ceramic Non- reflective Pavement markers	Number (No.)



## **PART (9): MINIMUM TESTS REQUIRED**

Add the following Part to conform with the Standard Specifications requirements.  
This Part contains the Minimum Tests Required for:

1. Earthworks
2. Base & Subbase
3. Concrete
4. Asphalt Mixes
5. Miscellaneous

**Minimum Tests Required**

Reference: General Specifications for Road and Bridges 1991 \*

**1. Earthworks**

Date: Jan, 1992

<b>Work Item</b>	<b>A Tests at source of material</b>	<b>Frequency for all tests mentioned under (A)</b>	<b>(B) Tests at Road site</b>	<b>Frequency for all tests mentioned under (B)</b>
1-1 Embankment	1) Soil Classification (AASHTO)  2) Any other tests or required in technical specs and drawings  3) C.B.R	- Test for each borrow pit  - Test for each cut area having suitable material  - When materials quality change	1. Maximum Dry Density (mod proctor)  2. Soil Classification (AASHTO)	- Test for each 1000 lin.m and for each layer.  - When materials quality change.
			3. Field Density 4. Any other tests as required by technical specs and drawings	- Test for each 1500 m2 or 100 Lin.m which ever be less, and for each layer.
1-2 Structural Backfill (at culverts)			1. Maximum Dry Density (mod proctor) 2. Granular Gradation 3. Plasticity Index	- Test for each structure - When materials quality change. - As requested
			4. Field Density 5. Any other tests as required by technical specs and drawings	- 50% of the layers or to the satisfaction of the Engineer.

\* Typed from the original tables received from MPW & H.

**Minimum Tests Required**

**1. Earthworks (Cont'd)**

<b>Work Item</b>	<b>A Tests at source of material</b>	<b>Frequency for all tests mentioned under (A)</b>	<b>(B) Tests at Road site</b>	<b>Frequency for all tests mentioned under (B)</b>
1-3 Structural Backfill at Bridge (piers)			1. Modified proctor 2. Granular gradation 3. Plasticity Index	- Test at each pier - When materials quality change. - As requested
			4. Field Density 5. Any other tests as required by technical specs and drawings	- 50% of the layers for each pier and to the satisfaction of the Engineer.
1-4 Structural Backfill at Bridges (abutments)			(same as above)	(Same as above)

**Minimum Tests Required**

**1. Earthworks (Cont'd)**

<b>Work Item</b>	<b>A Tests at source of material</b>	<b>Frequency for all tests mentioned under (A)</b>	<b>(B) Tests at Road site</b>	<b>Frequency for all tests mentioned under (B)</b>
1-5 Subgrade and shoulders	1. Granular Gradation 2. Plasticity Index 3. C.B.R 4. Any other tests as required in technical specs and drawings	- Test for each borrow pit - Test for each cut area having suitable material - Test for each 4000 m3 - When materials quality change	1. Modified proctor 2. Granular Gradation 3. Plasticity Index. 4. Soil Classification (AASHTO) 5. C.B.R	- Test for each 1000 lin.m, and for each layer.  - When materials quality change.
			6. Field Density 7. Any other tests as required by technical specs and drawings	- Test for each 1500 m2 or 100 Lin.m for each layer.
1-6 Selected subgrade	1. Granular Gradation 2. Plasticity Index 3. C.B.R 4. Any other tests as required in technical specs and drawings	- Test for each source - When materials quality change.	1. Modified proctor 2. Granular gradation 3. Plasticity Index 4. C.B.R	- Test for each 500 lin.m, and for each layer. - When materials quality change.
			5. Field Density 6. Layer thickness 7. Any other tests as required by technical specs and drawings	- Test for each 1500 m2 or 100 l.m for each layer.

**Minimum Tests Required**

**2. Base & Subbase**

<b>Work Item</b>	<b>A Tests at source of material</b>	<b>Frequency for all tests mentioned under (A)</b>	<b>(B) Tests at Road site</b>	<b>Frequency for all tests mentioned under (B)</b>
2-1 Base & Subbase	1. Granular Gradation 2. Plasticity Index 3. Abrasion 4. C.B.R 5. Sand equivalent 6. Fractured faces (for bases) 7. Any other tests or required in technical specs and drawings	- Test for each source - Test for each 2000 m3 - When materials quality change	1. Modified proctor 2. Granular gradation 3. Plasticity Index 4. C.B.R 5. Abrasion 6. Sand equivalent	- Test for each 500 lin.m and for each layer.  - When materials quality change.
			7. Field Density 8. Layer thickness 9. Any other tests as required by technical specs and drawings 10. Clay lumps & friable particles	- Test for each 750 m2 and for each layer.

**Minimum Tests Required**

**3. Concrete**

<b>Work Item</b>	<b>A Tests at source of material</b>	<b>Frequency for all tests mentioned under (A)</b>	<b>(B) Tests at Road site</b>	<b>Frequency for all tests mentioned under (B)</b>
3-1 Fine aggregate for concrete	<ol style="list-style-type: none"> <li>1. Gradation and fineness modulus.</li> <li>2. Specific gravity and water absorption.</li> <li>3. Sand equivalent</li> <li>4. Organic and harmful materials</li> <li>5. As requested in the special specs. and drawing</li> <li>6. Sulphates &amp; chlorides</li> </ol>	<ul style="list-style-type: none"> <li>- Test for each source</li> <li>- Test for each 2000 m3</li> <li>- When materials quality change</li> </ul>	<ol style="list-style-type: none"> <li>1. Gradation and fineness modulus.</li> <li>2. Specific gravity and water absorption.</li> <li>3. Sand equivalent</li> <li>4. Organic impurities &amp; deleterious substances</li> <li>5. Any other tests as requested in the special specs and drawing.</li> <li>6. Sulphates &amp; chlorides</li> <li>7. Soundness test</li> </ol>	<ul style="list-style-type: none"> <li>- Test for each source</li> <li>- Test for each 300 m3</li> <li>- When materials quality change.</li> </ul>
3.2 Coarse aggregate for concrete	<ol style="list-style-type: none"> <li>1. Gradation</li> <li>2. Specific gravity and water absorption.</li> <li>3. Abrasion</li> <li>4. Harmful materials and organic impurities</li> <li>5. Clay lumps and friable materials. Elongated and flaky particles Index.</li> <li>6. Any other tests as required in technical specs and drawings</li> </ol>	<ul style="list-style-type: none"> <li>- Test for each source</li> <li>- Test for each 2000 m3</li> <li>- When materials quality change</li> </ul>	(Same tests mentioned under A) in addition to: <ol style="list-style-type: none"> <li>1. Abrasion test</li> <li>2. Percentage of clay lumps and friable particles</li> <li>3. Flakiness index &amp; Elong, index.</li> </ol>	<ul style="list-style-type: none"> <li>- Test for each source</li> <li>- Test for each 300 m3</li> <li>- When materials quality change.</li> </ul>

**Minimum Tests Required**

**3. Concrete (Cont'd)**

<b>Work Item</b>	<b>A Tests at source of material</b>	<b>Frequency for all tests mentioned under (A)</b>	<b>(B) Tests at Road site</b>	<b>Frequency for all tests mentioned under (B)</b>
3-3 Combined aggregates for concrete	<ol style="list-style-type: none"> <li>1. Must satisfy fine and coarse aggregate requirements.</li> <li>2. Gradation</li> </ol>	<ul style="list-style-type: none"> <li>- Test for each source</li> <li>- Test for each 4000 m3</li> <li>- Test at change of material</li> </ul>	<ul style="list-style-type: none"> <li>- Must satisfy fine and coarse aggregate requirements</li> <li>- Gradation</li> </ul>	<ul style="list-style-type: none"> <li>- Test for each source</li> <li>- Test for each 500 m3</li> <li>- Test at change of material</li> </ul>
3-4 Water for concrete	<ol style="list-style-type: none"> <li>1. PH.</li> <li>2. Sulphates &amp; chlorides</li> <li>3. Water effect in concrete strength and properties.</li> <li>4. Greeze and oil.</li> </ol>	<ul style="list-style-type: none"> <li>- Test for each source</li> <li>- When source change</li> </ul>	<ul style="list-style-type: none"> <li>- Same tests mentioned under (A)</li> </ul>	<ul style="list-style-type: none"> <li>- Test for each source</li> <li>- When source changed</li> </ul>
3-5 Concrete admixtures	<ol style="list-style-type: none"> <li>1. Manufacturer certificate</li> </ol>	<ul style="list-style-type: none"> <li>- One for each type or manufacture</li> </ul>	<ul style="list-style-type: none"> <li>- Trial mixes to check suitability and percentages to be used based on site conditions, materials and manufacturer's recommendation.</li> <li>- Any other tests as requested in the special spec and drawing</li> </ul>	<ul style="list-style-type: none"> <li>- One for each type or manufacture.</li> </ul>

**Minimum Tests Required**

**3. Concrete (Cont'd)**

<b>Work Item</b>	<b>A Tests at source of material</b>	<b>Frequency for all tests mentioned under (A)</b>	<b>(B) Tests at Road site</b>	<b>Frequency for all tests mentioned under (B)</b>										
3-6 Concrete (fresh) 3-6-1 Trial Mix Design			<ol style="list-style-type: none"> <li>1. Slump test</li> <li>2. Cubes or cylinders for crushing strength as specified</li> <li>3. Workability</li> </ol>	<ul style="list-style-type: none"> <li>- Test for each class of concrete.</li> <li>- Test for change in any material</li> </ul>										
3-6-2 Ready Mix	<ol style="list-style-type: none"> <li>1. The concrete and all its constituents shall satisfy all concrete and materials requirements as specified.</li> <li>2. Workability</li> <li>3. Any other tests as required in technical specs and drawings</li> </ol>	<ul style="list-style-type: none"> <li>- For each source</li> <li>- When any materials is changed</li> </ul>	<ol style="list-style-type: none"> <li>1. Slump test</li> <li>2. Compression Tests (Take cubes)</li> <li>3. Any other tests as required in technical specs and drawings</li> </ol>	<ul style="list-style-type: none"> <li>- For each transit mixer</li> </ul> <table border="1"> <thead> <tr> <th>No. of Transit Mixers</th> <th>No. of sample</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>6</td> </tr> <tr> <td>2-5</td> <td>12</td> </tr> <tr> <td>6-10</td> <td>18</td> </tr> <tr> <td>11-20</td> <td>24</td> </tr> </tbody> </table> <ul style="list-style-type: none"> <li>- For each 10 additional transit mixes take 6 additional samples (Test half the samples after week and the next half after 28 days).</li> </ul>	No. of Transit Mixers	No. of sample	1	6	2-5	12	6-10	18	11-20	24
No. of Transit Mixers	No. of sample													
1	6													
2-5	12													
6-10	18													
11-20	24													



**Minimum Tests Required**

**3. Concrete (Cont'd)**

<b>Work Item</b>	<b>A Tests at source of material</b>	<b>Frequency for all tests mentioned under (A)</b>	<b>(B) Tests at Road site</b>	<b>Frequency for all tests mentioned under (B)</b>
3-6-3 Concrete Tests			1. Compression tests	- 6 specimens for every less or equal 80 m3. - 6 specimens for each casting day.
			2. Workability 3. Slump	- Test for each transit mixer at casting location.
3-7 Hardened Concrete			1. Core samples 2. Any other tests as required in the technical specs and drawing	- 3 cores for each part of a structure that did not satisfy the compression test after 28 days. - If samples are not taken during casting. - 3 cores for each part of a structure

**Minimum Tests Required**

**4. Asphalt Mixes**

<b>Work Item</b>	<b>A Tests at source of material</b>	<b>Frequency for all tests mentioned under (A)</b>	<b>(B) Tests at Road site</b>	<b>Frequency for all tests mentioned under (B)</b>
4-1 Materials in Asphalt mix. (At Batching plant)	<ol style="list-style-type: none"> <li>1. Specific gravity and water absorption.</li> <li>2. Abrasion test</li> <li>3. Chart content</li> <li>4. Clay lumps and friable particles</li> <li>5. Flaky and elongated particles</li> <li>6. Soundness</li> </ol>	<ul style="list-style-type: none"> <li>- Test for each source</li> <li>- When materials quality change.</li> <li>- As requested</li> </ul>		
4.2 Materials used in Asphalt mix (from hot bins)	<ol style="list-style-type: none"> <li>1. Gradation</li> <li>2. Specific gravity and water absorption.</li> <li>3. Plasticity index</li> <li>4. Sand Equivalent</li> <li>5. Stripping with asphalt</li> </ol>	<ul style="list-style-type: none"> <li>- Test for each source</li> <li>- When materials quality change</li> <li>- As requested.</li> </ul>		

**Minimum Tests Required**

**4. Asphalt Mixes (Cont'd)**

<b>Work Item</b>	<b>A Tests at source of material</b>	<b>Frequency for all tests mentioned under (A)</b>	<b>(B) Tests at Road site</b>	<b>Frequency for all tests mentioned under (B)</b>
4-3 Asphalt mix design each layer (At Batching Plant)	<ol style="list-style-type: none"> <li>1. Complete mix design in according with American Asphalt Institute (MS2)</li> <li>2. Loss of stability</li> </ol>	<ul style="list-style-type: none"> <li>- For each project</li> <li>- When materials quality change.</li> <li>- When results are not consistent with the mix design results.</li> <li>- As required.</li> </ul>		
4-4 Asphalt mix for each layer	<u>At Batching plant</u>	<ul style="list-style-type: none"> <li>- Test each 3 working days</li> <li>- Test for each batching plant.</li> <li>- As requested</li> </ul>	<u>Behind spreader</u>	<ul style="list-style-type: none"> <li>- Test each working days</li> <li>- Test for each batching</li> <li>- As requested</li> </ul>
			<ol style="list-style-type: none"> <li>1. Stability</li> <li>2. Flow</li> <li>3. Extraction (binder content and gradation)</li> <li>4. Air voids</li> <li>5. Voids in mineral aggregates.</li> <li>6. Daily marshall density</li> </ol>	
	7. Loss of stability	<ul style="list-style-type: none"> <li>- As requested</li> <li>- Once a week</li> </ul>	<ol style="list-style-type: none"> <li>7. Road density and thickness (after final compaction)</li> <li>8. Loss of stability</li> </ol>	<ul style="list-style-type: none"> <li>- Test each 200 lin.m per lane and for each layer</li> <li>- As requested</li> <li>- Once per week</li> </ul>

**Minimum Tests Required**

**5. Miscellaneous**

<b>Work Item</b>	<b>A Tests at source of material</b>	<b>Frequency for all tests mentioned under (A)</b>	<b>(B) Tests at Road site</b>	<b>Frequency for all tests mentioned under (B)</b>														
5-1 Concrete pipes (Plain / reinforced plant)	<ol style="list-style-type: none"> <li>1. Abrasion</li> <li>2. Proof &amp; Ultimate loads</li> <li>3. Materials used pipes shall satisfy each individual material requirement as specified</li> <li>4. Any other tests as required in the technical specs and drawings</li> </ol>	As per Specifications	<ol style="list-style-type: none"> <li>1. Absorption</li> <li>2. Proof &amp; Ultimate loads</li> <li>3. Any other tests as required in the technical specs and drawings</li> </ol>	As per Specifications														
5.2 Reinforced steel	<ol style="list-style-type: none"> <li>1. Tensile strength</li> <li>2. Yield point</li> <li>3. Elongation</li> <li>4. Bending</li> <li>5. Dimensions</li> <li>6. Any other tests as required in the technical specs and drawings</li> </ol>	- For each source 3 specimens for each diameter (Specimens to be taken from different bars)	<ol style="list-style-type: none"> <li>1. Tensile strength</li> <li>2. Yield point</li> <li>3. Elongation</li> <li>4. Bending</li> <li>5. Dimensions</li> <li>6. Any other tests as required in the technical specs and drawings</li> </ol>	<table border="0"> <thead> <tr> <th><u>Shipment load (Tons)</u></th> <th><u>No. of Specimens</u></th> </tr> </thead> <tbody> <tr> <td>&lt; 10</td> <td>1</td> </tr> <tr> <td>10 – 50</td> <td>2</td> </tr> <tr> <td>51 – 100</td> <td>3</td> </tr> <tr> <td>101 – 500</td> <td>4</td> </tr> <tr> <td>501 – 1000</td> <td>6</td> </tr> <tr> <td colspan="2">Over 1000 tons divide shipment into the above mentioned ranges in accordance with Jordanian specifications.</td> </tr> </tbody> </table>	<u>Shipment load (Tons)</u>	<u>No. of Specimens</u>	< 10	1	10 – 50	2	51 – 100	3	101 – 500	4	501 – 1000	6	Over 1000 tons divide shipment into the above mentioned ranges in accordance with Jordanian specifications.	
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# **IRREGATION WORKS**

## **SECTION 1 – SITE CONSTRUCTION**

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### **01 IRRIGATION SYSTEM**

#### **GENERAL**

#### **01.1 System Description:**

The system is designed to irrigate ground covers, shrubs and trees.

The system consists of one irrigation pumping station, consisting of three pumps; Two for irrigation network one of them is duty pump that will be turned on twice a week for 10 hrs and the other is standby pump, and one pump for fountain, the suction line for irrigation network is connected to the concrete water reservoir through a strainer with (150 mesh).

Water is then connects out to the main network , The system is manually controlled by the control valves, located on different locations on the site.

The design and layout are shown on the accompanying plans, while the equipment requirements are summarized in the specifications.

#### **01.2 Requirements:**

The irrigation contractor shall provide comprehensive installation records and instructions, operation and maintenance guidelines to ensure that the system is installed and operated as designed.

An irrigation engineer is to be made available on site as necessary, to supervise the installation of the system, towards the putting into operation.

The irrigation contractor shall provide detailed information on the items on the B.O.Q which he proposes to use for the irrigation system.

#### **01.3 Work includes:**

01.3.1 Supply, install, test and maintain all the irrigation system components as detailed later in this section, together with any related equipment and materials needed to put the system into successful operation.

01.3.2 Setting in operation and commissioning the irrigation system.

01.3.3 Demonstrating and instructing the system operation to owner and/or his representative.

#### **MATERIAL**

All materials and equipment incorporated in the system shall be new, free of any flaws or defects, and of quality and performance as specified to meet the system's requirement.

#### **01.4 Water reservoirs:**

The irrigation tank is reinforced concrete tank of capacity about 71 cubic meters, the concrete and steel reinforcement specifications should be followed, and other sections related to the tank must be considered.

#### **01.5 Pumping station:**

- 01.5.1 The pumping station consists of three electrical motor driven horizontal pump.  
The pump should have a water lubricated mechanical seal and bearings.  
The pump shaft and impeller shall be of stainless steel. The pump chamber shall be of cast iron.

The motor is totally enclosed to class IP54, fan cooled and to class F insulation.

Irrigation Pumps have the following specifications:

$Q = 4.0 \text{ m}^3/\text{hr}$  @ total dynamic head = 4 bars.

Fountain pump has the following specifications:

$Q = 3.0 \text{ m}^3/\text{hr}$  @ total dynamic head = 3 bars.

Also the irrigation pumps should be controlled by a control panel as in below:

- Timer will be set to work 10 hours every 3.5 days and to be switched off at rainfall storms.

- 01.5.2 Isolating valves shall be fitted to suction delivery connections with non-return and strainer fitted on irrigation network suction pipe.

- 01.5.3 The pumping station shall include the following equipment, as well:

- Pressure switches
- Flow meter, having the same size as the main line.
- Pressure vessel of 50 L capacity.
- Pressure gauges.
- Low level sensor, to prevent dry run.

- 01.6 Control panel :

Automatic control panel shall be mounted on the tank in a dust-tight splash proof enclosure and shall contain the following:

- Duty selector switches.
- Control circuit and line fuses.
- Motor starters.
- Pressure switch and low water level sensor terminals.
- Power -ON pilot light.
- Pump running light.
- Pump tripped light.
- Timer to control the pump and turning it on and off at time specified on drawings.
- All proper circuit breakers and contactors and other equipment deemed as required to enable the system to function properly and safely.

- 01.7 HDPE network :

- 01.7.1 Pipes:

High density polyethylene drip lines shall be made of 100 % virgin materials, and conforming to ISO 3126.

All high density Polyethylene fittings are high pressure saddles and quick joints having a minimum rating of 8 bars working pressure.

- Pipes shall be of High Density Polyethylene pressure pipes with the following dimensions:

Nominal Diameter (mm)	Wall Thickness (mm)	Inside Diameter (mm)
50	4.6	40.8
32	3	26
25	2.3	20.4
20	2.0	16

01.7.2 HDPE fittings:

All HDPE fittings are high pressure joints having a rating of 10 bar working Pressure and conforming to thermal connection.

01.8 Isolating valves and accessories:

01.8.1 Isolating valves shall be ball valves Plastic Polypropylene Body.

Shall have a Nylon handle and chrome plated brass ball...

Shall be of class PN 10 and female threaded to BSP.

Shall be the same size of the main line.

Shall be installed in a suitable valve box, to ease the maintenance access.

01.8.2 Dual acting air vents shall be installed at the high points.

01.9 Emitters:

On-line emitters shall be of a nominal discharge of 6 l/hr, and of pressure compensating type, with silicon made rubber.

In-line emitters shall have a nominal discharge of 2 l/hr at spacing 50 cm center to center.

## EXECUTION

General:

01.10 Storage on site:

Pipes shall be stored protected from sun .All other equipment and materials shall be Stored in a secure place and being capable of maintaining the temperature below the manufacturer recommended temperature limitation.

01.11 Handling:

The pipes should be handled manually .If mechanical lifting is required the pipes shall be properly protected from scoring and other damages .Dragging of pipes shall be prohibited.

01.11.1 Cover or plug openings in pipes, fittings and all other equipment daily during construction to prevent any foreign materials from entry.

01.11.2 Construct all piping of full-length sections of pipe where ever possible. Join all pipes with approved joints only.

01.12 Installation:



- All pipes shall be installed on slab under the tile at variable depth below surface depending on the architectural details.
- Pipes running in agricultural soil shall be directly buried in soil.
- All pipes which shall be exposed to sun shall be totally painted.
- Contractor shall install all items in strict accordance with the printed Recommendations of the manufacturer, installing each item firmly in position, level, plump and properly connected.
- Special foundations, holding down anchors or other fixing devices shall be provided as required.

01.13 Cleaning of the system:

As the installation of the various system components are completed, they shall be adequately cleaned before final closing. All foreign matter shall be removed from equipment and surrounding areas. Preliminary or final tests should not be permitted until the cleaning is certified by the supervising engineer.

01.14 Operation and Handing-over:

01.14.1 Pressure test:

At the end of network installation, and before the laterals and emission devices installation, the pressure test should be carried out as follows:

- 1.5 times the working pressure, for 15 minutes
- At the working pressure, for 24 hours.

01.14.2 System flushing:

The entire irrigation network should be flushed thoroughly before installing the emission devices.

01.14.3 Performance test:

The performance should be tested to assure efficient water delivering at adequate amounts to the plants, and uniform distribution for the ground covers areas.

01.14.4 Demonstration:

The Contractor shall be responsible for demonstrating the system operating to the supervising engineer.

01.14.5 Handing-over

The irrigation contractor shall hand-over the system to the supervising engineer as a final handing-over, and no works shall be accepted as completed unless it has the written approval of the Engineer.

END OF SECTION

# **MECHANICAL WORKS**

**DIVISION**

**MECHANICAL**

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15190	Mechanical Identification
15210	Equipment Bases, Supports and Vibration Isolation
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15411	Plumbing Valves
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**SECTION 13310**

**FIRE PROTECTION PIPING**

**PART 1 GENERAL**

1.01 SCOPE OF SECTION

- A. This technical specification establishes the minimum requirements for the equipment to be incorporated into the infrastructure and above ground fire protection pipe work.

1.02 WORK INCLUDED

- A. Provision of all labour, materials, and the performance of all operations necessary for the supply and installation of pipe work, controls and equipment of the Fire Water Systems as specified herein and as detailed on the Drawings.
- B. Coordination: The Contractor shall ensure that the Fire Water Systems are fully compatible with all trades, particularly those of the Civil, Mechanical and Electrical services, for successful installation and operation.
- C. Submittals: The Contractor shall submit to the Engineer for review and approval, all calculations and drawings for the equipment proposed and associated builders works to show that the plant as installed will meet all the specified criteria.

No works shall commence on the production of the package or associated site works until the design has received the approval of the Engineer.

1.03 QUALITY ASSURANCE

- A. Manufacturers: The Contractor shall only propose the use of firms who have been regularly engaged in the manufacturer of Fire Water Pumps and Equipment and whose products have proved satisfactory in similar service for not less than 10 years.
- B. Installer: Firms proposed for the installation of the Fire Water Pumps and Equipment shall have been regularly engaged for at least 5 years in the installation of plants of a similar type, quality and scope as is required for this project.

1.04 APPLICABLE CODES AND STANDARDS

- A. The Fire Water System shall comply with the latest relevant National Fire Protection Association (NFPA) codes and standards in all respects.
- B. The following are the most commonly used NFPA standards associated with Fire Water Systems. However, the Contractor shall ensure all applicable NFPA standards are complied with, whether here or not.

- NFPA 1 - Fire Prevention Code.
- NFPA 14 - Standard for the Installation of Standpipe, and Hose Systems
- NFPA 20 - Standard for the Installation of Centrifugal Fire Pumps
- NFPA 22 - Standard for Water Tanks for Private Fire Protection

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### 1.05 SUBMITTALS

- A. Drawings - refer to Section 15010
- B. Products - submit full manufacturer's data for every item.
- C. Provide samples of pipe work showing each type of joint to be used.
- D. Full systems Calculations.

### 1.06 OPERATION MAINTENANCE DATA

- A. Comply with Section 15010.

### 1.07 WARRANTY

- A. Provide 12 month warranty in accordance with contract conditions.

## **PART 2 PRODUCTS**

### 2.01 GENERAL

- A. Pipe work and fittings shall be as specified or approved equivalent and shall be manufactured fully in accordance with the relevant NFPA Codes and Standards.
- B. Pipe work and fittings that have been subject to corrosion or damage shall not be acceptable.
- C. An underground system of pipe work and valves shall be extended to hydrants and building fire fighting systems as indicated on the drawings.
- D. All goods and products shall be new and free from any surface rust or mill scale.
- E. All individual lengths of pipe work or individual valves shall be stamped with their manufacturer's name, date, place of origin, size and class of duty. All fittings shall be stamped for traceability and quality assurance, the engineer can ask for information subjected to this at any time.
- F. All pipe work and fittings (screwed, and grooved) shall be suitable for the working pressure, operating temperatures and conditions of the fluids flowing within them. The declared pressure rating of the pipe work shall be equal to or greater than the maximum test pressure of the system.
- G. The working pressure for pipe work, connections and fittings is based on the total static pressure in the pipe work in addition to the operating pressure exerted by the pumps on the system. All Fittings and valves shall have 1.5 pressure rating of the system, taking into consideration pump close discharge pressure.

### 2.02 ABOVE GROUND PIPING

- A. Steel Pipe: ASTM A53/A53M, Grade B; ASTM A135/ASTM A135 UL listed, threadable, light wall; ASTM A795; or ASME B36.10; Schedule 40 black.
  - 1. Steel Fittings: ASTM A234/A234M, wrought carbon steel and alloy steel.

2. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.
  3. Mechanical Formed Fittings: Carbon-steel housing with integral pipe stop and O-ring pocked & O-ring uniformly compressed into permanent mechanical engagement onto pipe
  4. Joints: AWWA C111, rubber gasket.
  5. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped composition sealing gasket, steel bolts, nuts, and washers.
- B. All fittings for heavy weight steel tube shall be heavy weight weld fittings to NFPA 13 & 14. Pressure rating of fittings and valves shall be as stated in point G above.
- Flanges for pipe work shall be of the weld neck type. The use of slip on flanges will not be permitted.
- Nuts, bolts and washers shall be of bright mild steel and the bolts shall be of the correct length and show a minimum of two threads after tightening.
- D. Pipe work for screwing shall be seamless black steel schedule 40 tube to NFPA 13 & 14 supplied with screwed and socketed ends.
- E. Bends and swept tees shall be used throughout. The use of elbows will not be permitted and square tees will be allowed only where vent connections are taken off.
- F. Grooved mechanical pipe coupling, fitting, valves and other grooved components shall be used for pipe size above 50 mm. All grooved components shall be from one manufacturer and shall be UL/FM listed. Grooved end product manufacturer shall be ISO 9001 certified. Pipe grooves shall be rolled in accordance with ANSI/AWWA standard C-606. Coupling shall be cast of ductile iron conforming to ASTM A536 Grade 65-45-12 or malleable iron conforming to ASTM A-47 Grade 32510. Jointing rings shall be grade "E" EPDM compound (green colour coded) conforming to ASTM D-2000 designation 2CA615A25B24F17Z. Temperature operating range -34°C to +110°C. Samples of pipe groove and couplings are to be submitted to the Engineer for approval.

## 2.02 UNDER GROUND PIPING

- A. Underground Installation fire fighting network shall be High Density Polyethylene Pipe (HDPE), pipe shall be run underground, in trenches and using suitable backfilling material, Pipes shall be PE 80 PN 16 to EN 12201 and ISO 4427 in accordance with NFPA 13 & 14..
- B. All fittings for HDPE pipes shall be HDPE fittings to NFPA 13 & 14.
- C. HDPE shall not be installed above ground.
- D. HDPE pipe joints shall be electro fusion welding.

## PART 3 EXECUTION

### 3.01 INSPECTION OF FIRE SERVICES PIPEWORK

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- A. The Contractor shall inspect all products for damage immediately before installation. Any products that are damaged or not in accordance with this Specification shall immediately be repaired or removed from the site and replaced.
- B. Grooved joint shall be installed in accordance with the manufacturer's written recommendations. Grooved ends shall be clean and free from indentations, projections, or roll marks. AGS "Advanced Groove System" shall be applied for pipe size above 300 mm , groove shall be wider with a wedge shape groove side, grooving tool shall be produced by the coupling manufacturer. The gasket shall be molded and produced by the coupling manufacturer of an elastomer suitable for the intended service. The coupling manufacturer's factory trained representative shall provide on-site training for the contractor's field personnel in the use of grooving tools and installation of product. The representative shall periodically visit the job site to ensure best practices in grooved product installation are being followed. (A distributor's representative is not considered qualified to conduct the training.)

### 3.02 HANDLING OF FIRE SERVICES PIPEWORK

- A. All pipes, and piping accessories shall be inspected at time of delivery for damage and for compliance with this Specification.
- B. Any products that are damaged or found not to be in accordance with this Specification shall be immediately repaired or replaced. Such repairs shall be done only after the approval of the Engineer.
- C. All products shall be handled and stored as recommended by the manufacturer to prevent damage and deterioration.
- D. The Contractor shall supply handling equipment such as lifting beams, reinforced cranes are used, protective padding, struts, cradles, etc., required to install products without damage.
- E. The Contractor shall unload all products singly from trucks or lorries. Unless cranes are used, pipes shall be unloaded by means of skids and check ropes and no pipe shall be dropped.
- F. Each pipe unit shall be site stored, stacked and handled into its position in the trench only in such manner, and by such means, that affords total protection for it from damage of any kind. Site stacking of pipe work shall be such that the pipe work shall not deform or be damaged in any way through storage or retrieval. The manufacturer's recommendations shall be taken as the minimum requirements.

### 3.03 GENERAL INSTALLATION

- A. The runs of pipe work indicated on the Drawings are as accurate as possible. They shall be taken as diagrammatic only and all pipe work shall be installed in the neatest possible manner in the space available. Where this involves special fittings or settings of pipe they shall be provided by the Contractor, even though they are not indicated on the Drawings. Where possible pipe work, shall be run parallel to, or at right angles to the building walls.
- B. Where changes in direction are required and because of either lack of space or for neatness, fittings are not suitable, 'offsets' shall be installed as follows:-
  - A 'Formed Bend', for a change in direction of less than 90 degrees.
  - A 'Single Offset', made up of two formed bends, returning the pipe to the same direction.

- A 'Double Offset', made up of four formed bends, returning the pipe to the same direction and the same axis.

In all instances the offsets shall be 'Cold Drawn' and on no account shall heat be applied.

All sets, double sets and springs shall be formed on long lengths of tube with as large a radius as possible and all shall be free from distortion.

- C. All pipework shall be installed in such a manner as to ensure the automatic release of air and ease of drainage.

Any pipework fitted in an unsightly manner and not to the satisfaction of the Engineer shall be removed and re-fitted at the Contractor's own expense.

The Engineer shall have the right to inspect any pipe, pipe joint or pipe line fitting in order to check quality of materials and workmanship or system operation. Any defects shall be made good by the Contractor at his own expense and to the satisfaction of the Engineer.

- D. All pipes shall be at least 150mm from lighting and power cables or conduit unless otherwise specifically indicated on the Contract Drawings.

Pipes shall not be located above electrical equipment or in any other position where pipe leaks could cause liquids to come into contact with electrical equipment.

- E. Pipework shall be installed such that there is a minimum clear distance of 75mm to the finished floor level and a minimum clear distance of 25mm to the finished wall face from adjacent pipework services.

All pipework, which is to be insulated, shall allow space for each pipe to be insulated around its whole circumference. Adequate clearance shall be provided between insulated pipework running together and adjacent to walls and floors. Clearances between insulation and floor and insulation and wall shall be as for bare pipework.

All pipework shall be installed such that they can be dismantled and are accessible for repair and replacement. Where valves and equipment are fitted, unions and flanges shall be provided as appropriate for the size of the pipework in order to allow removal of valves and equipment.

- F. No joints shall be formed in the thickness of walls, floor slabs or roof slabs. No pipework shall be chased into floor slabs, roof slabs or walls. During the installation period open ends of pipework shall be capped off using purpose-made plugs or blank counter flanges. Pipework shall be kept free of dirt and other foreign debris at all times.

All pipework buried in concrete or in accessible trenching or underground shall be wrapped in 'Denso Tape'. The tape shall be fixed strictly in accordance with the manufacturer's instructions. Buried pipes shall be painted by two layers of zinc rich anti corrosion paints before wrapping with "Denso tape".

- G. All pipework shall be arranged so that thermal expansion or contraction may be readily taken up by bends or changes in direction. Refer to Section 15512 Hydronic Expansion Compensation. For Victaulic Grooved system, flexible couplings can be used in lieu of expansion joints to accommodate for thermal expansion and contraction, manufacturer written study shall be submitted directly for this purpose.

- H. All pipework shall be plumbed in the vertical and levelled to the turn of a bubble in the horizontal, except where wall of floor finishes deviate from the vertical or horizontal, in which case the pipework shall be parallel to the surface to present a neat appearance.



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- J. All high points shall be provided with automatic air vents with weep lines piped to drain. Automatic air vents shall be connected to full-bore "air bottle" connections from service pipe to ensure good air collection.

All low points shall be provided with valve drain connections. Where these occur in areas not having free access, the Contractor shall pipe the drain position to the nearest drain point, to be agreed with the Engineer.

- K. Due allowance shall be made for all necessary reducers, matching flanges, etc. to equipment, whether detailed or not.
- L. Where pipework crosses expansion joints in buildings, flexible couplings shall be employed in the pipework system to take account of both contraction and expansion of the pipework and the building structure. A manufacturer submittal shall be written directly for this purpose. Axial compensators shall not be used on suspended pipework.
- M. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three Victaulic flexible couplings can be installed instead of each connector, and shall be placed in close proximity to the vibration source.
- N. HDPE pipe shall be installed in accordance with manufacturers recommendations.

### 3.04 UNDER GROUND WELDED PIPEWORK

- A. Joints on all permanently concealed pipe work and all pipe work over 50mm size shall be welded. At dismantling points or where the pipe work is connected to an appliance, ground-in spherical seated unions shall be used for pipe work up to 50mm size and flanges shall be used for pipework 65mm size and above.

All flange joints shall be flush and truly aligned and shall employ klingerite joint rings coated on both sides with an approved jointing compound.

- B. All welding joints shall be made by oxy-acetylene or electric arc process strictly in accordance with BS 2640 and BS 2633 respectively and subsequent amendments. Welding shall be carried out in accordance with "Recommended Practice for Oxy-Acetylene Welds in Mild Steel Pipelines" issued by the Association of Heating, Ventilation and Domestic Engineering Employers, United Kingdom.
- C. All welded joints shall be executed by first-class certified welders working under skilled supervision. All craftsmen shall be experienced in this particular class of work for a period of not less than 12 months immediately preceding the commencement of the welding work called for in this Specification.

The welder responsible for the work with his own identifying die shall stamp each weld forming part of the installation.

- D. During the welding process proper attention shall be given to correct alignment of pipe and fittings. The correct degree and duration of preheat shall be applied and the weld made with proper welding rod or electrode between properly prepared ends. Upon completion of the weld, the correct degree and duration of post-weld treatment shall be applied to ensure normalisation of the weld. All welds shall be of good clean metal, free from slag, of even thickness and contour, well fused with the parent metal, annealed and hammered upon completion and finished smooth prior to painting.
- E. No rusty pipe work or fittings shall be used for welding prior to being thoroughly wire brushed.

"Flamecut" entries into pipe work may be used, but cut edges shall be filed smooth and all swarf and cuttings removed from the bore of the pipe prior to the fitting being welded

to the pipe. Square tee welds shall not be permitted. Long radius branch bend fittings shall be used for all sweep connections from mains in lieu of welding tees.

- F. The Engineer reserves the right to have up to 2% of all welds cut for his examination. The cutting of these selected welds and remaking shall be carried out at no extra cost. Should a test weld prove to be unsound and not in accordance with the Specification, the Engineer shall be entitled to cut further test pieces of work by the welder responsible for the fault. A maximum of 20% of this faulty welder's work may be cut out and remade at no extra cost. Should further welds prove to be unsound the Engineer reserves the right to instruct all welds made by the faulty welder to be cut out and remade at no extra cost. Should the Engineer's opinion be that the unsound/imperfectly made welds are due to faulty workmanship the Engineer shall have the right to insist on the suspension of the welder responsible.
- G. Should it be deemed necessary by the Engineer, radiographic inspection of welds may be requested. This radiographic examination shall be restricted to concealed pipework in trenches, voids, horizontal and vertical shafts and false ceiling voids. Radiographic examination of welds shall be carried out in accordance with BS 2910 and the Contractor shall employ a specialist firm approved by the Engineer to carry out this work.

### 3.05 GROOVED PIPEWORK

In lieu of welding or threading Fire protection piping systems, the systems may be installed by using Victaulic mechanical pipe couplings of a bolted or mechanical locking device type for use on wet and dry automatic sprinklers, inspector drain lines, outside protection, low pressure carbon dioxide, FM-200, Halon and Halon replacement systems, then the following guidelines will be adhered to.

- A. Pipes: Pipe shall be in compliance with NFPA 13 and NFPA 14 according to ASTM A-53 and/or A-135, and shall be UL listed and FM approved for 300 psi working pressure.
- B. Cut Grooved & Threaded pipes shall be schedule 40 equivalent according to ASTM A-53. All pipes shall have a Corrosion Resistance Ratio, (CRR) of 1.00 or greater, per UL listings.
- C. Pipe ends to be grooved in accordance with Victaulic current listed standards conforming to ANSI/AWWA C-606 using Victaulic grooving tools.
- D. Pipe Joining Method: Pipes shall be joined via the Victaulic grooved FireLock Style009 and Style 005 Rigid Coupling with Angle Pad Design for pressures up to 350psi. Rigid couplings shall be fully installed at visual pad-to-pad offset contact. Tongue-and-recess type , Butt-in type couplings, or any coupling that requires exact gapping of bolt pads or pipes at required torque ratings, are not permitted. Style 07 Zero Flex Design shall be used for pressure ratings above 350psi. Victaulic Style 77 or 75 shall be used where system flexibility is required, at pumps and mechanical equipment to reduce vibration and noise. All couplings shall be cast of ductile iron conforming to ASTM A-395, Grade 65-45-15. Housings shall be red or orange enamel coated or hot dip galvanized.

For size above 12 inch Victaulic AGS coupling and AGS valves shall be used. Coupling housings designed with the wedge-shaped AGS key profile to engage the mating pipe(s)/component(s) wedge-shaped AGS grooves. Housings include lead-in chamfer to accommodate a wider acceptable range of initial pipe positions. Housings shall be coated with orange enamel or galvanized.

- E. Gaskets: Shall be Grade "E" EPDM compound (green color coded) conforming to

ASTM D-2000, UL listed classified to ANSI/NSF 61 for water supply systems and Flush Seal gaskets for dry service. All gaskets shall be selected as per manufacturer's recommendation according to service application. Gaskets must be manufactured by the same source for couplings and fittings to secure compatibility.

- F. Grooved Fittings and Coating: Shall be cast of ductile iron conforming to ASTM A-395, Grade 65-45-15 with grooved or shouldered ends for direct connection into the grooved piping system. Fittings shall be orange or red enamel coated or hot dip galvanized.
- G. Branch Outlets - Hole Cut Pipe: Hole cut branch outlets with pressure rating of 27 bar or above, shall be Victaulic style 920, 920N Mechanical T branch connections with locating collar emerging into the hole. Branches shall have a machine cut hole at a predetermined position, on the centerline of the pipe, of a size to receive the housing collar, in accordance with Victaulic specifications using Hole Cut Machines.
- H. Shut Off & Butterfly Valve: Shall be Victaulic Series 705-W or 705 as UL listed and FM approved for 300psi (2065 kPa) service supplied with a ductile iron body conforming to ASTM A-536 coated with a polyphenylene sulfide blend, a disc of ductile iron conforming to ASTM A-536, with EPDM pressure responsive seat providing bubble tight shut off. Stem shall be offset from the disc centerline to provide complete 360-degree circumferential seating. Sizes 2½-6" (65-150 mm) shall have an approved weatherproof manual actuator suitable for indoor or outdoor use with two single pole, double throw supervisory switches either pre-wired (WRD) or unwired (UWD) monitoring the open position. The 8" (200 mm) size will be either unsupervised or will feature factory installed DPDT switches monitoring the open position. Valves shall be installed in accordance with the latest published Victaulic specification. AGS valves for sizes above 12" (300 mm).
- I. BALL VALVES : Shall Be Victaulic Series 728 as UL listed and FM approved for 300psi (2065 kPa) Cast steel body; stainless steel, full bore, floating; Teflon seat and stuffing box seals; lever/key operation; grooved ends Base Design of Victaulic 728.
- J. Check & Non Return Valve: Shall be Victaulic series 717 and 717R Vic-Check single disc, spring loaded, check valves 2½ - 12" (65-300 mm) as UL listed and FM approved for a single check and anti-water hammer service for horizontal or vertical installation, supplied drilled, tapped and plugged downstream for drainage outlet with Grade "E" EPDM seal, housing cast of ductile iron conforming to ASTM A-536 Grade 65-45-12 with grooved ends for installation with Victaulic grooved end couplings rated for service up to 250 PSI (1725 kPa) working pressure.
- K. Alarm Test Module: Shall be Victaulic Style 720 Test Master II for sizes 1" to 2" Thread by Thread (NPT or BSPT) and sizes 1-1/4" to 2" Groove by Groove, with a choice of ½" or 17/32" combination sight glass/orifice. The Alarm Test Module shall be based on a 90 degree angle pattern design, to be used for both right and left-hand placement in a fire protection test and drain system. Bronze body and Bonnet with polycarbonate sight glass.
- L. To easily allocate sprinklers, a flexible branch pipe can be installed; flexible branch shall be a stainless steel open-gate multiple-use flexible drop system. The drop system shall include all required bracing and supports. Aquaflex Series AQC braided flexible drop system for clean room ceilings shall consist of a stainless steel braided flexible hose, 304 stainless steel adapter ring, reducer, nipple, braid, and collar, with a zinc-plated carbon steel fixing plate and EPDM O-ring. The drop shall be FM Approved to 175psi(12bar) with no required welding

- M. Fire Alarm Valve shall be Victaulic Series 751 / 759. The alarm valve should be closed in the static position with the pressure below and above the valve, at normal level and no water flow. In the event of a pressure drop above the valves due to activation of a sprinkler head, water is admitted to the branch pipe connected to the water motor alarm and the gong. The alarm valve internal components shall be replaceable without removing the valve from the installed position. Basis of Design: Victaulic Series 751 / 759.

### 3.05 SCREWED PIPEWORK

- A. All pipework 50mm and below shall be screwed except where it is permanently concealed.

The threading of screwed joints shall be carefully made and shall be cut to produce an accurate thread free from burrs, snags and swarf. At least one of the engaging components shall be taper threaded. All ends of pipe shall be reamed to restore full bore prior to assembly. Subject to these provisions, threading may be carried out by hand or by automatic machine.

- B. Screwed joints shall be made using P.T.F.E. tape. Joints shall be pulled up tightly and all extruded jointing material shall be removed and the joint left clean.
- C. Where pipes are held in vices for threading, care shall be taken to ensure that the pipe surface is not damaged. Any pipework so damaged shall not be fitted.
- D. All pipework joints shall be cleaned thoroughly to remove traces of tape prior to painting with a final coat of red oxide.

### 3.06 PAINTING OF PIPEWORK AFTER INSTALLATION

- A. All ferrous surfaces to be wire brushed and painted with one coat of red oxide paint after installation.
- B. Refer to Division 9 for painting.

### 3.07 SYSTEM TESTING OF FIRE SERVICES PIPEWORK

- A. General:
1. The Contractor shall ensure that all pipework is watertight to the satisfaction of the Engineer and shall supply all pressure gauges, meters, hoses, pumps and all temporary supports, equipment and manpower necessary for carrying out pressure tests.
  2. The Contractor shall, during testing, check the satisfactory operation of each valve and hydrant installed under the Contract.
- B. System Test:
1. Before filling or pressure testing is started the Contractor shall re-check pipes and valves for cleanliness and shall re-check the operation of valves. The open ends of the pipes shall normally be stopped off by blank flanges or capped ends additionally secured where necessary by temporary struts and wedges.
  2. Fire water systems shall be suitable for the working pressure, operating temperatures and the conditions of the fluids flowing within them. The declared pressure rating of the pipework shall be equal to or greater than the maximum test pressure of the system. The testing shall be carried out in sections if necessary. If a section should fail the test, the Contractor shall trace and repair

all leaks and defects and retest the section before any further pipes or section of adjacent pipework are laid.

3. The working pressure for pipework connections and fittings is based on the total static pressure in the pipework in addition to the operating pressure exerted by the pumps on the system.
4. The system shall be filled with potable water and all air expelled. After the system has been completely filled, the pressure shall be steadily and gradually increased until the test pressure has been reached. If any loss is recorded, repairs shall be made and the test re-run.

C. Test Results:

Upon completion of the tests, written records of every test clearly identifying the tested section of the pipe together with time of test and name of testing engineer in tabulated format shall be submitted to the Engineer for review.

3.08 FLUSHING AND DISINFECTION

- A. Fire services pipelines shall be flushed with potable water after completion of pressure testing and before disinfections.
- B. Liquid chlorine, calcium hypo chlorite or sodium hypo chlorite shall be used for disinfections. Where liquid chlorine is used, it shall be introduced only in conjunction with proper equipment and under the supervision of qualified personnel familiar with the physiological, chemical and physical properties of liquid chlorine and who are suitably trained and equipped for dealing with any emergency which may arise from its use.
- C. Fire service water from a suitable source shall be injected with flow control at a constant and measured rate. The water shall receive a dosage of chlorine fed at a measured constant rate to ensure chlorine concentration in the water entering the pipe is maintained at a minimum of 50mg/l. The chlorine residual shall be measured at regular intervals to ensure that the required chlorine concentration is maintained.
- D. During the application of chlorine, valves shall be manipulated to prevent the treatment dosage from flowing back into the line supplying the water. Chlorine application shall continue until the entire pipeline is filled with chlorine solution.
- E. After 24 hours retention, the heavily chlorinated water shall be flushed out with potable water, until the chlorine concentration in the water leaving the pipeline does not exceed 1 mg/l. Chlorine residual determination shall be made to ascertain that the heavily chlorinated water has been removed from the pipeline.
- F. Flushing water shall be discharged only to sites or into conduits. Discharges, which cause damage, create nuisance or health hazard, or interfere with the work of others will not be permitted.

END OF SECTION 13310

**SECTION 13311**

**FIRE PROTECTION VALVES**

**PART 1 GENERAL**

1.01 SCOPE OF SECTION

- A. This technical specification establishes the type and quality of materials, and the standard of workmanship to be used in the supply and installation of fire protection valves.

1.02 WORK INCLUDED

- A. The work includes the provision of all labor, materials and the performance of all operations in connection with the supply and installation of valves as specified herein and where referred to on the drawings.
- B. Coordination: The contractor shall be responsible for the full coordination of the work of all trades.

1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of valves whose products have been in satisfactory use in similar applications for not less than 10 years.
- B. Installer: Firms regularly engaged and qualified in the installation of valves with at least 5 years successful installation experience on projects of a similar nature.

1.04 APPLICABLE CODES AND STANDARDS

- A. The valves and all associated materials shall comply with NFPA Standards and be UL listed.

1.05 SUBMITTALS

- A. Drawings - refer to Section 15010
- B. Products - submit full manufacturers data for every item.

1.06 OPERATION AND MAINTENANCE DATA

- A. Comply with Section 15010.

1.07 WARRANTY

- A. Provide 12 month warranty in accordance with contract conditions.

**PART 2 PRODUCTS**

2.01 GENERAL

- A. Bodies of valves and cocks on mild steel pipe work up to and including 50mm size shall be of cast gunmetal or bronze. Approved valves having hot-pressed bodies may be

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offered as an alternative. Bodies of valves 65mm size and larger shall be of cast iron. Castings and pressings shall be of good quality, clean and smooth and free from scale or flaws.

- B. Holes in covers or in gates for screwed portions of spindles shall have full threads of a length not less than the diameter of the spindle over the thread. Glands shall be machined to provide a running fit between the spindle and the stuffing box. Stuffing boxes shall be properly packed or fitted with "O" rings, which may be located in plastic bushes.
- C. Valves and cocks on mild steel pipe work up to and including 50mm size shall have taper screwed ends, and of 65mm size and above shall have flanged ends.
- D. All screwed valves shall have heavy hexagonal reinforcements at openings, threads of ample length to ensure sound joint and heavy shoulders to prevent over entry of pipes, fittings or adapters.

Flanged valves shall have flat-faced flanges.

- E. All valves and valve components (e.g. seating, packing, etc.) shall be suitable for the working pressures, operating temperatures and conditions of the fluid handled in the systems in which they will be installed. All valves shall be hydraulically tested to at least twice the working pressure of the systems in which they will be installed. where necessary valves shall have extended spindles to facilitate insulation. The declared pressure rating of the valve shall be equal to or greater than the maximum test pressure of the system.
- F. The working pressure for valves is to be based on the static pressure in the pipe work in addition to the operating pressure exerted by the pumps on the system.
- G. Each valve shall have the manufacturer's name or trade mark, the UL and FM listed, the nominal diameters, the nominal pressure rating and body material all identified in the form of stamped or cast body markings.
- H. Victaulic grooved valves and fittings may be used as an alternative.

### 2.02 ISOLATING VALVES

- A. Isolating valves up to and including 50mm nominal bore shall be bronze or gunmetal gate valves with solid wedge discs, non-rising stems, screwed in bonnets, metal hand wheels and screwed ends.
- B. Isolating valves for 65mm nominal bore and above shall be cast iron gate valves with solid wedge discs with bronze trim and seating, bolted on cast iron bonnets, high grade graphite asbestos free packing, rising stems with outside screws and yokes, cast iron hand wheels and flanged ends.
- C. Where shown on the drawings or specified herein, lock shield valves shall have easy-clean shields or enclosures to match the inlet valves. As a minimum requirement, one loose key shall be provided for every 25 N<sup>o</sup> valves of the same spindle size.

### 2.03 NON-RETURN VALVES

- A. Non-return valves up to and including 50mm nominal bore shall be of the bronze swing pattern with screwed ends.

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- B. Non-return valves 65mm nominal bore and above shall be of the cast iron swing pattern with bolted access covers, solid discs with bronze trim and seating ends. An air cock shall be fitted to the bolted cover for air release purposes.

### 2.04 DRAIN VALVES

- A. Drain valves shall be of the bronze straight type glanded pattern complete with brass hose union and malleable iron lever.

### 2.05 AIR COCKS

- A. Air cocks shall be nickel or chrome plated, of the spoutless pattern and with screwed tape thread. Two loose keys shall be provided for each installation having up to 10 air cocks and one loose key shall be provided for every additional ten air cocks.

### 2.06 AUTOMATIC AIR VENTS

- A. Automatic air vents shall be of bronze or gunmetal construction. Vents shall be designed to eliminate air from the system automatically without passage of water. The unit shall be of the float operated type screwed connection on the outlet to enable the unit to be piped to a remote drain position.

### 2.07 TEST & DRAIN VALVES

- A. All bronze, angle valve with screwed ends complete with metering orifice, discharge tundish etc.

### 2.08 ALARM TEST VALVE

- A. All bronze multi-port plug valve with screwed ends, operating lever and engraved position lever attached to body.

### 2.09 STRAINERS

- A. All bronze 'Y' type strainer with screwed ends, screwed cover and 30 mesh stainless steel screen for alarm supply line.

### 2.10 WATER MOTOR ALARM

- A. All bronze construction of through the wall type with threaded inlet and outlet connections, wall sleeve, drive shaft and bell.

- 2.11 HDPE Valves: Shall be rising stem gate valves for direct buried installation.

## **PART 3 EXECUTION**

### 3.01 STORAGE

- A. All valves shall be stored within a well lit container on purpose made compartmented racks or shelves, constructed in a similar manner to support the entire weight of materials without noticeable deformation.



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- B. The valves shall be separated by means of their type and size and laid out in an orderly manner for ease of identification.
- C. Valves shall be supplied and stored with purpose made or manufactured plugs to prevent ingress of dirt.

### 3.02 GENERAL INSTALLATION

- A. Valves with screwed ends shall have a union installed adjacent to the valve for ease of dismantling.
- B. Where possible, valves shall be installed with the stem in the vertically upright position. However, all valves shall be installed in a manner such that they are readily accessible for ease of operation.
- C. Sufficient clearance shall be allowed for the application of thermal insulation, valve boxes, etc. and to ensure that full travel of the valve stem can be achieved.

### 3.03 ISOLATING VALVES

- A. Separate isolating valves shall be provided on all pipe work services to each item of plant or equipment and on each main and sub main, except where flow measuring or regulating valves are required and these valves can be used for isolating purposes without affecting their measuring or regulating functions.

### 3.04 MEASUREMENT AND REGULATING VALVES

- A. Flow measurement valves shall generally be installed on the flow pipe work with the regulating valve installed on the return pipe work.
- B. Where a particular valve manufacturer recommends the use of a double regulating valve, close coupled to a measuring station as a means of flow measurement and regulation at one point, then the commissioning station shall be installed on the return pipe work.
- C. All regulating devices shall be of the double regulating type and each shall be installed in the fully open position.
- D. Flow measurement valves and commissioning stations shall be installed a minimum of 6 pipe diameters up-stream and 12 pipe diameters down-stream of any fitting which would create water turbulence.
- E. All flow measurement valves shall be installed with sufficient clearance around the test points to enable commissioning instruments to be connected.

### 3.05 DRAIN VALVES

- A. Drain valves shall be installed at all system low points on the dead side of isolating valves and on all items of plant to facilitate emptying down and removal.
- B. Line sized drain valves shall be installed at the end of each pipe work run and at the base of each pipe work riser to enable the system to be adequately flushed.

### 3.06 AIR VENTING DEVICES

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- A. Air venting devices shall be installed at all system high points.
- B. Automatic air eliminators shall be complete with galvanized mild steel relief pipe work, taken to within 1.5 m of the floor level with a gunmetal isolating valve and extended to a position where any discharge will not damage building fabrics, decorations or the like.
- C. Air bottles shall be made from 50mm size tube. Each shall be a minimum of 150mm long, fitted with a cap and 8mm size air cock. Where an air bottle is fixed out of reach, a 15mm extension tube shall be run from the cap to within 1.5m of the floor level and terminating with a needle valve and hose union.

### 3.07 RETARD CHAMBERS

All controlling valves, alarms and indicator switches shall have retard chambers adjustable from 0-90 seconds to avoid false alarms.

- 3.08 All O.S.&Y valves shall be fitted with supervisory switches wired back to central fire indicator panel

END OF SECTION 15311

**SECTION 13312**

**FIRE PROTECTION SUPPORTS, HANGERS AND BRACKETS**

**PART 1 GENERAL**

1.01 SCOPE OF SECTION

- A. This technical Specification establishes the type and quality of materials and the standard of workmanship to be used in the supply and installation of Supports, Hangers and Brackets.

1.02 WORK INCLUDED

- A. The work includes the provision of all labor, materials and the performance of all operations in connection with the supply and installation of Supports, Hangers and Brackets as specified herein and where referred to on the Drawings.
- B. Coordination: The Contractor shall be responsible for the full coordination of the work of all trades.
- C. All work shall be in accordance with NFPA 13.

1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of Supports, Hangers and Brackets whose products have been in satisfactory use for a similar application for not less than 10 years.
- B. Installer: Firms regularly engaged and qualified in the installation of pipework systems with at least 5 years successful installation experience on projects of a similar nature.

1.04 APPLICABLE CODES AND STANDARDS

- A. The Supports, Hangers and Brackets and all associated materials and workmanship shall comply with the latest NFPA, ASHRAE and SMACNA requirements.

1.05 SUBMITTALS

- A. Drawings - Refer to Section 15010.
- B. Products - Submit full manufacturers data for every item.

1.06 OPERATION AND MAINTENANCE DATA

- A. Comply with Section 15010.

1.07 WARRANTY

- A. Provide 12 month warranty in accordance with contract conditions.

**PART 2 PRODUCT**

2.01 GENERAL

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- A. All supports, hangers and brackets shall be of an approved manufacture and shall conform to the requirements of NFPA 13 and NFPA 14. All hangers and supports of fire protection network shall be of the seismic type. Calculation of loading along with support and hanger selection, and shop drawing shall be submitted to Engineer for approval.
- B. All steel products used for support systems if not manufactured from malleable cast iron or stainless steel shall be either galvanised or painted with one coat of red oxide paint.
- C. All drop rods shall be galvanised and sized to suit the bracket type and system weight but in no case shall be less than 6 mm diameter.
- D. All materials used for support systems shall be compatible with the material they are supporting. Generally all steel pipework shall be supported by cast iron and steel clips while UPVC pipework shall be supported by brass or PVC clips. Where galvanised steel pipework is used all pipework clips shall be galvanised.
- E. Where brackets are exposed to view they shall be of a chrome plated finish.
- F. Fixings to concrete and masonry shall be of the expanding bolt or wedge anchor type selected in accordance with the manufacturers recommendations and suitable for the imposed loads. Where fixings are to be made close to the outside edge of concrete or masonry structures resin banded fixings shall be used to reduce the risk of fracture.
- G. Brackets for fixing to woodwork or light weight partitioned walls shall be of the screw on pattern.
- H. Purpose made girder clamps shall be used where any system is supported from steelwork and only with the approval of the Engineer.
- I. Provide sway bracing be in accordance with NFPA 13.

### **PART 3 EXECUTION**

#### 3.01 STORAGE

- A. All continuous lengths of channel angle and screwed rod shall be stored on purpose made pipe racks of welded construction and of sufficient strength to support the entire weight of the material without any noticeable deformation. The racks shall be such that all material is clear of the ground.
- B. All raw metal shall be wire brushed and painted with one coat of red oxide paint prior to storage.
- C. All general support materials shall be stored within a well lit container on purpose made compartmented racks or shelving. The materials shall be separated by means of their type and size and laid out in an orderly manner for ease of identification.

#### 3.02 GENERAL

- A. All systems shall be adequately supported in such a manner as to permit free movement due to expansion, contraction, vibration or other changes in the system. Supports shall be arranged as near as possible to joints and changes in direction.

- B. Vertical rising pipes and ducts particularly in shafts shall be adequately supported at the base to withstand the total weight of the riser. Under no circumstances shall branches from vertical rising pipes be the means of support for the vertical pipework.
- C. Hangers for horizontal systems at high level shall be supported from angle or channel irons suitable for securing to the structure.
- D. Pipework shall be independently supported, double stacking of pipes from the same support will not be permitted.
- E. Adjustable mild steel hangers on steel pipework systems shall be used with swivel joints at the pipe rings and spherical washers at the top of the hanger rods. Pipe rings shall be malleable cast iron or fabricated steel made in halves and secured by bolts or screws. Malleable iron hinged pipe rings may also be used but caliper hooks shall not be permitted. Pipework 65 mm diameter and over shall not be supported using malleable iron brackets. All pipe brackets over 50 mm diameter shall be submitted to the Engineer and approved by the Engineer prior to manufacture.
- F. Where rollers and chairs are required, these shall be preformed and where used singularly they shall have restraining "U" straps or bolts formed over the diameter of the pipe and bolted to the base support of the chair. The "U" straps or bolts shall be fitted to allow movement of the pipe without binding. Continuously threaded "U" bolts will not be permitted.
- G. The spacing of supports shall be determined in accordance with the following table. Where one support carries more than one pipe of different diameters the spacing shall be determined by the requirement of the smallest diameter.

Table 9.2.2.1(b) Maximum Distance Between Hangers (m-mm)

	Nominal Pipe Size (mm)											
	20	25	32	40	50	65	80	90	100	125	150	200
Steel pipe except threaded lightwall	NA	3.66	3.66	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57
Threaded lightwall steel pipe	NA	3.66	3.66	3.66	3.66	3.66	3.66	NA	NA	NA	NA	NA
Copper tube	2.44	2.44	3.05	3.05	3.66	3.66	3.66	4.57	4.57	4.57	4.57	4.57
CPVC	1.68	1.83	1.98	2.13	2.44	2.74	3.05	NA	NA	NA	NA	NA
Ductile-iron pipe	NA	NA	NA	NA	NA	NA	4.57	NA	4.57	NA	4.57	4.57

NA: Not applicable.

Figures are for normal ambient temperatures below 20°C. For temperatures above 20 °C the pipe manufacturer should be consulted, based on average temperature of 40 °C.

Maximum spacing of fixings for internal piping shall conform to the requirements of NFPA 13 and NFPA 14.

END OF SECTION 13312

**SECTION 13325**

**FIRE PROTECTION SYSTEMS AND EQUIPMENT**

**PART 1 GENERAL**

1.01 SCOPE OF SECTION

- A. This technical Specification establishes the quality of materials and workmanship to be used in the supply and installation of the Fire Protection systems and equipment used internally within buildings.

1.02 WORK INCLUDED

- A. Provisions of all labour, materials and the performance of all operations in connection with the installation and testing fire protection and fire fighting systems within buildings as specified herein and shown on the drawings.
- B. Coordination: The Contractor shall be responsible for proper coordination of the work of all trades and shall provide clear drawings where necessary.

1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of fire fighting and fire protection systems and equipment fittings whose products have been in satisfactory use in similar service for not less than 10 years.
- B. Installer: Qualified with at least 5 years of successful installation experience on projects with fire fighting and fire protection schemes and equipment similar to that required for this project.

1.04 APPLICABLE CODES AND STANDARDS

- A. The Fire Protection systems and equipment shall comply fully with the latest relevant National Fire Protection Association standards in all respects.
- B. The following are the most commonly used NFPA Standards associated with Fire Protection systems. However, the contractor shall ensure that all applicable NFPA Standards are complied with, whether listed here or not.

NFPA 1 - Fire Prevention Code.

NFPA 10 - Standard for Portable Fire Extinguishers.

NFPA 13A - Recommended Practice for the Inspection, Testing and Maintenance of Sprinkler Systems.

NFPA 13E - Recommendations for Fire Department Operations in Properties Protected by Sprinkler and Standpipe Systems.

NFPA 14 - Standard for installation of Standpipe and Hose Systems.

NFPA 17 - Standard for Dry Chemical Extinguishing Systems.

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NFPA 20 - Standard for The Installation of Stationary Pumps for Fire Protection

NFPA 1961 - Standard for Fire Hose.

NFPA 1963 - Standard for Screw Threads and Gaskets for Fire Hose Connections.

### 1.05 SUBMITTALS

- A. Drawings - refer to Section 15010
- B. Products - submit full manufacturers data for every item.

### 1.06 OPERATION AND MAINTENANCE DATA

- A. Comply with Section 15010.

### 1.07 WARRANTY

- A. Provide 12 month warranty in accordance with contract conditions.

## **PART 2 PRODUCTS**

### 2.01 GENERAL DESCRIPTION

- A. All materials, equipment and procedures associated with the Fire Protection Systems shall be in accordance with NFPA requirements.
- B. Where operating or warning instructions are provided or specified they shall be clearly denoted in local language and English.
- C. The Contractor shall supply original authenticated certificates for each type of material or equipment, confirming the standard they have been manufactured and tested to.

### 2.02 FIRE PUMPS

Fire pumps shall conform fully to NFPA Standards and shall be UL/FM Listed.  
The pumping unit shall meet the requirements of NFPA 20.  
All pumps and their drives shall be mounted on a reinforced concrete foundation of an adequate construction and dimensions.  
All pumps shall be located in accessible locations for ease of repair and maintenance.  
All pumps shall be provided from the factory with plugged connections for casing vent, drain, suction and discharge pressure.  
All pumps shall be constructed of materials having a working pressure rating of 24 bar.  
All pipes, fittings, and instrumentations shall have a working pressure of 24 bars.  
All pumps shall be tested at the factory to provide detailed performance data and to demonstrate its compliance with specifications.  
Drains from base plate, pump, relief valves ..etc. shall be piped to the drain located inside the pump room.

Fire pump set shall consist of the followings:

- A. Electric driven fire pump end suction type.
- B. Electric driven fire pump end suction type connected to emergency generator
- C. Jockey Pump.

Capacity of pumps shall be as stated in schedules. Control panels shall be UL/FM listed. Test line and flow meter with all corresponding valves and fittings shall be provided.

Main pumps shall be of horizontal split case type. The pump and driver shall be mounted on a common steel base plate adequately reinforced against deflection and provided with drip rim and bolt holes.

The pump shall be directly connected to the driver through a heavy duty flexible coupling and provided with heavy gauge coupling guard from the factory. The base plate shall be securely supported on the foundation in such a way that proper pump and driver shaft alignment will be assured.

The base plate, with pump and driver mounted on it, shall be set level on the foundation and secured with proper size anchor bolts and completely grouted in to provide a rigid, non deflecting support. Pump and driver shall be aligned at the factory.

Realignment is required after grouting in of base plate and after connection of piping.

The pump casing shall be of high tensile strength close-grained cast iron fitted with bronze wearing rings.

The impeller shall be bronze of the enclosed type and fitted to the shaft with stainless steel key. The impeller shall be dynamically balanced at the factory.

The shaft shall be stainless steel amply sized to carry out all axial and radial thrust. The shaft shall be protected by stainless steel sleeves.

The pump rotating element shall be supported by heavy duty grease lubricated ball bearings mounted in a heavy iron housing. The bearing shall be lubricated by screw type grease cups.

The pump shall be provided from the factory with mating flanges for suction and discharge connections.

The pumps shall be selected so that the operating point of specified flow and head shall falls near the maximum efficiency point as obtained from the manufacturer published data. The pump shall never be selected to operate near the end of its curve.

The pump shall deliver not less than 150% of rated flow at a pressure not less than 65% of rated pressure, the shut off pressure shall not exceed 140% of the rated pressure.

Pump shall be provided with a relief valve set below the shut off pressure to provide circulation of sufficient water to prevent the pump from overheating when operating with no discharge flow. A 20 mm relief valve shall be used/.

Provision shall be made for a discharge to drain.

The pump shall be provided with main relief valve. This relief valve shall be located between the pump and the pump discharge check valve. The relief shall discharge into the water reservoir at a point as far from the pump suction as is necessary to prevent the pump from drafting air introduced by the drain pipe discharge. Drain pipe shall enter the reservoir below the normal water level.

A shutoff valve shall not be installed in the relief valve supply or discharge lines.

Each pump shall be provided with float operated air release valve not less than 15 mm diameter size.

A pressure gauge shall be connected to the discharge side of the pump casing. A compound pressure and vacuum gauges shall be connected to the suction side of the pump casing.

Gate valves of outside screw and yoke (OS&Y) shall be installed on the suction and discharge piping of the pumps.



Check valves of the silent, non slam, spring loaded type shall be installed on the pump discharge piping.

Suction pipes shall be laid carefully to avoid air pockets. When section pipe and pump suction flange are not of the same size, they shall be connected with an eccentric tapered reducer in such a way to avoid air pockets.

The entrance of suction pipe in the water reservoir shall be provided with anti-vortex plate. Flexible coupling shall be installed on the suction pipe connected to the water reservoir.

Water measuring devices shall be provided to test the fire pumping unit. Water measuring devices shall consist of flow meter and sensor. They shall be capable of measuring a flow of not less than 175% of the rated capacity. The size shall be as stated in NFPA 20 and as indicated on drawings.

Jockey pump shall be of the centrifugal vertical multi stage type. The pump casing shall be cast iron. The pump impeller shall be bronze, and the shaft shall be stainless steel the pump shall be fitted with gate valves (OS&Y) on suction and discharge pipes, a check valve on discharge pipe, a relief valve on pump discharge, size 15 mm diameter, an automatic release valve on top of pump casing, one pressure gauge on pump discharge, and one compound pressure and vacuum gauge on pump suction.

The motors of electric driven shall be of squirrel cage induction type and rated for continuous operation at ambient temperature not less than 46 deg C.

The motors shall be totally enclosed fan cooled type with insulation class F and IP 54 protection. The motors shall be rated for 415/230 volts, 3 phase and 50 cycle. The motor shall be designed for Delta –Star start for fire pump, and across the line start for jockey pump.

The locked rotor current of the motor shall not exceed approximately six times the full load current. The motor shall be sized so that the full load ampere will not be exceeded.

All motor terminals shall be marked in accordance with NEMA standards. All motors shall be provided with name plates in accordance with NFPA 70.

The power supply feeder of the fire pumping unit shall be sized at 125% of the sum of the full load currents of duty fire pump jockey pump and auxiliary loads.

Motor power factor shall not be less than 0.85.

The hors power rating of the motor driving the pump shall be of such magnitude as to ensure non-overloading of the motor throughout the capacity range of the pump for the impeller size selected.

Electric drive controllers shall be specifically listed for electric motor driven fire pump service and marked "Electric Fire Pump Controller".

All controllers shall be completely assembled, wired, and tested by the manufacturer before shipment from the factory.

All controllers shall indicate plainly the name of the manufacturer, the identity designation and the complete electrical rating.

All controllers shall be mounted in a proper panel enclosed in a moisture and dust tight housing.

All controllers shall be so located or protected that they will not be injured by water from pumps on pump connections.

All enclosures shall be grounded.

Bus bars and other wiring elements of controllers shall be designed on a continuous duty basis.

A fire pump controller shall not be used as a junction box to supply other equipment. Electrical supply conductor for jockey pump shall not be connected to the fire pump controller, it shall have a separate controller.

All switching equipments for manual use in connecting, or disconnecting, or starting, or stopping the motor shall be extremely operable.

Wiring diagrams and complete instructions covering the operation of the controllers shall be provided and permanently attached to the inside of the controller enclosure.

The controllers shall be of combined automatic and manual type. Each operating component of the controller shall be labeled to indicate an identifying number referenced to the circuit diagram

Electric drive controllers for fire pump and jockey pump shall be provided with the following components and control devices in accordance to NFPA20 requirements, and shall be UL and FM.

Isolating switch of molded case type externally operable having an ampere rating not less than 115% of the motor full load current.

Circuit breaker of protecting the motor branch circuit of molded case time delay type having a continuous current rating not less than 115% of the rated full load current of the motor, and an interrupting rating equal to or greater than the available short circuit current for the circuit in which it is used.

Locked rotor over current protective device of time delay having trip setting approximately six times the rated full load current of the motor.

Motor starter of magnetic type capable of being energized automatically through the pressure switch or manually by means of an external operable handle.

Pressure actuated switch having independent high and low calibrated adjustment in controller circuit. This pressure switch shall be responsive to water pressure in the fire protection system.

The pressure sensing line shall be 15 mm nominal size of copper or stainless steel suitable for the system pressure. The connection of the sensing line shall be made between the pump discharge check valve and gate valve.

The pressure sensing element of the switch shall be capable of withstanding a momentary surge pressure of 27 bar without losing its accuracy.

Manual operated switch for manual starting of the pump motor,

The pump shall remain in operation until manually shutdown.

Manual mechanical control to provide for non automatic continuous running operation of the motor independent of any electric control circuit.

Manual shutdown of automatic controller by reset push button to the controller's full automatic position.

Electrical cables feeding fire pumps shall be fire rated cables.

### 2.03 HOSE REEL CABINET

The cabinet and door leaf shall be made of 1.5 mm steel sheet with all around folded edges, door leafs hinged flush mounted or doorframe. The cabinet shall be equipped with vertical wired glass window on front door. The cabinet shall be painted red with electrostatic powder paint. The cabinet shall be complete with the water connections placed to suit the supply pipes. The door shall be recessed type with aluminum turn handle chrome plated.

The cabinet shall consist of the following:

1. Hose reel of 30 m length.
2. 6 kg dry powder Potable Fire Extinguisher

### 2.04 HOSEREEL & HOSERACK

- A. 30 m of 25 mm UL, FM rubber hose suitable for a working pressure of 1034 kPa mounted on a revolving drum. Lever operated control nozzle of 6mm orifice, swing type with jet/spray. The reel to be fitted with an automatic valve to operate when 3 meters of hose is unwound. The drum shall be painted red. The reel shall be supplied complete with cabinet with water connection placed to suit the supply pipe. Each hose reel shall be

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provided by pressure reducing valve. Hose racks shall be provided with pressure reducing station to maintain a pressure of less than 1034 kPa.

- B. Hose rack: 30m of 65 mm diameter hose made of synthetic single jacket hose, UL, FM, with test pressure of 34 bar and bursting pressure of 48 bar.
- B. Each hose reel shall be complete with locally fixed operating instruction plate.
- C. Each hose reel cabinet shall contain one multi purpose dry powder extinguisher 6 kg capacity.

### 2.05 SIAMESE CONNECTION ASSEMBLY

- A. Siamese connection assembly shall be installed for use of fire brigade as shown on the drawings.
- B. The Siamese connection assembly shall be bronze with four inlets. Each inlet shall consist of a 65 mm instantaneous male coupling and a non-return valve protected with a cap secured by a suitable length of chain.
- C. The Siamese connection shall be according to NFPA 24 and UL listed and FM approved
- D. The assembly shall include 4-way inlet breeching; drain valve, concrete support and other details. The Siamese connection assembly connection assembly mounted horizontally shall be installed in steel cabinet with glazed door. Horizontal inlet box with door fitted with Georgian wired glass panel marked "wet riser inlet" or "dry riser inlet" according to the drawings and spring cylinder lock with key.
- E. The Siamese connection assembly shall have 150 mm flanged outlet for attachment to the dry or wet main.
- F. The assembly shall be finished with red color paint.

### 2.06 SPRINKLERS

- A. Sprinklers shall be installed as shown on drawings and in accordance with the requirements of NFPA 13.
- B. All Sprinklers shall be manufactured, tested and approved in accordance with the applicable standards of Underwriter Laboratories and Factory Mutual.
- C. Unless otherwise stated on drawings automatic sprinklers shall have a temperature rating of 68 deg C with bulb color red. Orifice diameter shall be 15mm with NPT thread type.
- D. Standard Upright sprinklers are to be installed in such a way that the water spray is directed upwards against the deflector, Upright sprinklers shall be installed in all areas containing exposed sprinklers piping.
- E. Side wall sprinklers shall have special deflectors that are designed to discharge most of the water a way from nearby of the wall in a pattern resembling one quarter of a sphere with a small portion of the discharge directed to at the wall behind the sprinkler.
- F. Deluge sprinklers shall be UL FM open type with orifice diameter of 25 mm.
- G. Sprinklers installed in restaurants kitchens shall have a temperature rating of 79 deg C minimum with bulb color yellow or green.
- H. Sprinklers shall be quick response type.

## 2.07 ALARM VALVE ASSEMBLY

- A. Alarm valve assembly shall be UL listed FM approved
- B. Alarm floor control valve shall comprise: indicating OS&Y gate valve equipped with tamper switch, test connection, drainage outlets and tundish, pressure gauge, water flow switch.
- C. Alarm valve assembly shall comprise: control check valve, indicating OS&Y gate Valve equipped with tamper switch, water flow switch, test connection, pressure gauge and drainage outlet with tundish.
- D. Water flow switch shall be UL listed FM approved, and constructed and installed in a manner that any flow of water from sprinkler system equal or greater than from a single automatic sprinkler will actuate the alarm system. Water flow switch including alarm circuits shall be tested by an actual water flow through use of the test connection.
- E. Tamper switch provided for the indicating gate valve shall initiate an alarm when the indicating valve is moved from the normal position. A test connection not less than 50 mm diameter, terminating in a smooth bore corrosion resistant orifice to provide a flow equivalent to one sprinkler flow, shall be installed and equipped with sight glass, drain valve and shut off valve.

## 2.08 PORTABLE FIRE EXTINGUISHERS

- A. Portable Fire Extinguishers shall be of the type indicated on the drawings and specified herein.
- B. The fire extinguishers shall conform to the requirements of NFPA 10 for design standard and performance with the classes of fire as defined in that standard and this Specification.
- C. Classes
  - Class A Fire involving solid materials, usually of an organic nature such as wood, cloth, paper, rubber and many plastics.
  - Class B Fires involving flammable liquids, oils, greases, tars, oil based paints, lacquers and flammable gases.
  - Class C Fires involving energized electrical equipment where the electrical non-conductivity of the extinguishing media is of importance.
- D. Multi-purpose dry powder (chemical)-Class A.B. and C fires. Multi-purpose dry powder extinguishers shall be ammonium phosphate, stored pressure type with steel cylinders, braided PVC or black reinforced rubber discharge hose and nozzle and pressure gauge. Suitable carrying handles shall be incorporated in the extinguisher body or the control mechanism moulding. Extinguishers shall be hermetically sealed to prevent moisture contaminating the powder.
- E. Carbon Dioxide (CO<sub>2</sub>) - Class B and C fires. Carbon Dioxide extinguishers shall have steel cylinders and be complete with swivel horn or hose and horn applicator.

- F. Water (H<sub>2</sub>O) - Class 'A' fires water extinguishers shall be stored pressure type with steel cylinders, braided PVC or black reinforced rubber discharge hose and nozzle and pressure gauge. Suitable carrying handles shall be incorporated in the extinguisher body or the control mechanism moulding.
- G. Foam - Class A and B fires. Foam extinguishers shall be of the stored pressure type with steel cylinders, braided PVC or black reinforced rubber discharge hose and nozzle and pressure gauge. Suitable carrying handles shall be incorporated in the extinguisher body or control mechanism moulding.
- H. Special Features

All portable extinguishers shall be wall bracket mounted as shown on the drawings. Wall mounted units shall be supplied complete with purpose made wall brackets, and the Contractor will secure these to the building structure so that the installed height of each extinguisher conforms to the NFPA Standard 10 Clause 1-6.9 relative to its gross weight. Where floor standing units are provided these shall be fitted with integral steel skirts such that the extinguisher body itself does not rest on the floor. Specific extinguisher requirements are shown on the drawings. Where concealed mounting is required the extinguisher shall be provided with all accessories required for such mounting.

All types of extinguisher shall be fitted with a locking pin arrangement to prevent accidental discharges, the safety pins being secured to the unit by a chain or wire cable to prevent loss.

- I. Design, Deployment and Capacity

The extinguisher designs shall be such as to facilitate inspection, cleaning, repair and replacement, and be simple and reliable when in use under operational (or training) conditions.

The mounting requirement for extinguishers shall be as shown on the Drawings. The Contractor shall not deviate from this requirement or other aspect of the specification without the permission of the Engineer.

The locations, type of extinguishant and capacity of fire extinguishers are shown on the relevant Drawings. The capacity of each unit specified is the minimum quantity of extinguishant required at the location indicated. The Contractor may supply slightly larger sizes to that specified where the Specification does not coincide with a particular supplier's production standard extinguisher. If the nearest standard deviates considerably from the Specification the Contractor shall obtain the approval of the Engineer before placing his order.

- J. Extinguisher Marking

All extinguishers shall carry in English and Local language clear and concise operating instructions and warnings against use on fires for which the extinguishant is not suitable, or any other warnings of which the operator must take heed. The extinguisher class suitability and warnings may take the form of pictorial labels as depicted in the NFPA Standard 10.

The following information shall also be clearly marked on the body of each unit:

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1. The name of the manufacturer.
2. Instructions for regular periodic checking of the units for operational serviceability.

### K. Portable Fire Extinguishers - Types and Sizes

1. Multi-purpose dry powder complete with wall bracket.

Capacity	6Kg	10Kg
Range & discharge	5-7m	5-7m
Duration of discharge	13secs	20secs
Blocked nozzle pressure at 20°C	13 bar	13 bar

2. Carbon Dioxide

Capacity	3 kg	5 kg	6 kg
Minimum range of discharge	3 m	5 m	3 m
Duration of discharge	17 secs.	15 secs.	17 secs.
Working pressure at 20°C	50 bar	50 bar	50 bar

3. Foam

Capacity	6 L	9 L
Minimum range of discharge	4 m	4 m
Duration of discharge	28 secs.	40 secs.
Working pressure at 20°C	12.5 bar	12.5 bar

4. Water

Capacity	10 L
Minimum range of discharge	6 m
Duration of discharge	65 secs.
Working pressure at 20°C	12.5 bar

## PART 3 EXECUTION

### 3.01 STORAGE

- A. All pipe work shall be stored on purpose made racks of welded construction and of adequate strength to support the entire weight of materials without noticeable deformation.
- B. All pipework shall be stored clear of the ground and with all open ends sealed with purpose made or manufactured plugs to prevent the ingress of dirt.
- C. All fittings shall be stored within a well lit container on compartmented racks or shelving, separated by their type and size and laid out in an orderly manner for ease of identification.

- D. Hose reels, fire extinguishers and fire blankets shall be covered in protective packaging and stored in a well lit container. Fire extinguishers in particular, shall be secured to prevent damage resulting from falling and in no instance shall they be subject to temperatures in excess of 50°C for to direct sunlight.

3.02 GENERAL INSTALLATION

- A. All items shall be installed in the locations indicated on the drawings and strictly in accordance with the manufacturer's instructions.
- B. The installation shall comply fully with all applicable standards and codes listed in Part 1.04.
- C. Pipe work shall be installed in accordance with relevant standards.
- D. Hose reels, fire extinguishers and fire blankets shall be securely fixed with approved fixings in a position offering unobstructed access.
- E. All hose racks shall be installed with an isolating valve and a union between the valve and pack to enable any reel to be removed without having to shut down the system.

END OF SECTION 13325

## SECTION 15010

### BASIC MECHANICAL REQUIREMENTS

#### PART 1 GENERAL

##### 2.02 SCOPE OF WORK

- A. This Section covers the basic general requirements applicable to all Division 15 works that shall be provided for by the Contractor.

##### 1.02 CALCULATIONS

- A. The Contractor shall acquaint himself with the constructional details of the buildings and exterior works both before and during the course of erection and shall take his own particulars with regard to the installation of mechanical equipment. The Contractor shall check the sizes of all mechanical equipment taking into account any additions or deletions required to ensure the installations fit into the room or other spaces allocated and in relation to other plant and equipment being provided.
- B. The Contractor shall undertake and prepare all necessary calculations and drawings relating to the mechanical equipment and for all associated foundation, structural and builder's and services work, except where specifically defined otherwise in the Specification and/or on the Drawing.
- C. The Contractor shall provide and submit to the Engineer all calculations, drawings and supporting data for the mechanical equipment.
- D. The Contractor shall provide calculations, details, drawings and technical data to enable the Engineer to ascertain the correctness of the specialist designs of the associated foundations, supports, bases and fixings.

##### 1.02 WORKING DRAWINGS

- A. The Contractor shall provide for approval working drawings of the whole mechanical works. The drawings shall include, but not necessarily be limited to the followings: -
  - 1. Coordinated general arrangements of all services to a scale of not less than 1:100
  - 2. Coordinated detailed layouts of plant rooms and similar spaces to a scale of not less than 1:50.
  - 3. Schedules of all equipments to be installed, together with start and running power consumption.
  - 4. Indicate with accurate dimensions sizes and positions of all plant, equipment, pipes, conduits, trunking, underfloor ducting, cable tray, cables together with all inspection points and cable joints.
  - 5. Fully indicate all ductwork, pipework, sizes and positions of all plant equipments and valves together with all inspection points and test positions.
  - 6. Fully indicate all builder's work requirements inclusive of all foundations, bases, plinths, sumps and holes together with the overall sizes and masses of the plant concerned.



7. Show the disposition and depth of all cables, pipes, ducts, buried direct in the ground and taken at intervals where change of direction occur and where cables increase or decrease in number/size and at every point where the services enter into or depart from ducts or buildings.
  8. Indicate the number, size and services for every cable, ducts, pipes for every service within the building. Circuit lists for every distribution board shall be entered onto the relevant drawings and such lists shall agree with the lists fixed within the distribution board door.
  9. Indicate all equipment and control wiring diagrams together with all specialist systems.
  10. Show all cables in pits and ducts on drawings to a scale of 1:50 or larger.
  11. Show clearly on site drawing all the new buildings together with all other existing buildings and other permanent features and dimensions between such buildings and cables, pipes, ducts, etc. clearly marked.
  12. Show clearly all plumbing and drainage and setting out dimensions for all drainage pipework and manholes, both within the building and throughout.
  13. The site, together with intended drainage pipework backfill, or surround in each location, schedule to be included to indicate manhole, and cover size, etc.
- B. The symbols used for each service for all working drawings shall be shown on separate drawings.
- C. In addition to the working drawings, the Contractor shall obtain and provide at the request of the Engineer, two sets of all manufacturer's detailed drawings for all items of plant, equipment, apparatus and materials. These drawings shall be suitably titled and have drawings references number added. Specific requirements are given in the individual specification Sections.
- D. All drawings, diagrams and schedules called for in this clause shall be submitted to the Engineer for examination and approval.
- E. The Contractor shall make due allowance for an approval/comment period and it must be clearly understood that the correctness of the submitted information will directly affect this comment/approval period.
- F. The Contractor shall be responsible for co-ordinating all mechanical, electrical, fire protection plumbing, drainage condensate, and irrigation works, and engineering systems such that each may be installed in a proper manner, ensuring correct performance and allowing adequate maintenance access. All services shall be installed such that the positioning of ducts, pipes, cables, and all items of equipment avoid conflict. The Contractor's working drawings shall indicate any services co-ordination needs prior to submission to the Engineer for approval; tender drawing shall not be reissued as working drawings.

#### 1.04 CONSTRUCTION DRAWINGS

- A. Following approval of the Contractor's drawings by the Engineer, they shall constitute "Construction Drawings" and the E and M equipment shall be manufactured and installed

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in accordance with those approved drawings. The acceptance by the Engineer of any such drawing shall not relieve the Contractor of his responsibility under the Contract and shall not commit the Engineer or make the Engineer liable for any mistake of the manufacturer's deficiencies in strength or efficiency in operation of any part of any item for its specified purpose.

- B. The Engineer reserves the right subsequently to amend or add to the Construction Drawings as may be necessary or expedient.
- C. The Contractor shall provide to the Engineer, immediately after approval of each detailed drawing, one copy on transparent plastic film and two dye-line prints.

### 1.05 REGULATIONS

A. The installation materials and components shall comply with all relevant statutory instructions and regulations current at the date of tender, whether so detailed or not. In particular, the following departments must be consulted.

1. Standards & specifications issued by Ministry of public works.
2. British Standard Specifications
3. British Standard Code of Practice
4. UK IEE Regulations for Electrical Installation
5. US National Electrical Code
6. US National Electrical Safety Code
7. UK Chartered Institution of Building Services Engineers (CIBSE)
8. The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
9. Water Regulations issued by Water Authority
10. Electrical Regulations issued by JEPSCO
11. US Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
12. UK HVCA DW142 Ductwork specification.
13. US National Fire Protection Association Standards
14. IEE Regulations for Electrical Equipment of Buildings
15. Local Laws, Rules and Regulations
16. U.K BSRIA code for pipework flushing.
17. US Air Conditioning and Refrigeration Institute (ARI)
18. US American Society for Testing and Materials (ASTM)
19. US Air Movement and Control Association (AMCA)
20. US Underwrites Laboratories (UL)

### 1.06 CLIMATIC AND OPERATING CONDITIONS

- A. City : Wadi Mousa
- Elevation : 1130 m above sea level
- Temperature : See specification clauses.

### 1.07 WORKMANSHIP AND MATERIALS

A. The Contractor shall be responsible for ensuring that the components or each system are mutually compatible and integrated to form fully efficient systems complying with the Drawings and Specification. Corresponding parts throughout the Works shall be made to gauge and be interchangeable wherever possible. The Contractor shall, when required by the Engineer, prove interchangeability by the actual interchange of the various parts.

- B. All articles and materials specified to conform to Jordanian, British and other standards shall be clearly and indelibly marked with the appropriate standard number specified except where marking is impracticable when relevant documents shall include this information.
- C. All materials and workmanship shall be to the satisfaction of the Engineer. The Contractor shall maintain a competent supervising engineer and supervisors for each specialisation and for each section of the work on Site throughout the whole of the time to the completion of the works. The Engineer shall give prior approval to the appointment of this supervising engineer and shall have the authority to withdraw this approval at any time. No person shall be allowed to execute any type of work, which is normally carried out by a skilled tradesman unless he is thoroughly experienced and proficient in the trade concerned. The Engineer shall have the authority to require any tradesman to demonstrate his proficiency to the satisfaction of the Engineer.
- D. Where "stainless steel" is specified or used it shall have resistance to atmospheric corrosion and be of a grade to suit its particular use. Particular attention shall be made to the prevention of seizure by fretting where two corrosion resistant metals are in contact, by the selection of materials of suitable relative hardness and surface finish and the applications of lubricants. Where bronze is specified or used it shall be zinc free.
- E. All cast iron shall be of standard grey close-grained quality to BS 1452 Grade 14 or better. The structure of the casting shall be homogenous and free from non-metallic inclusions and other injurious defects. All surfaces of casting which are not machined shall be smooth and shall be carefully fettled to remove all foundry irregularities.
- F. Minor defects not exceeding 12.5% of total metal thickness and which will not ultimately affect the strength and serviceability of the casting may be repaired by approved welding techniques. The Engineer shall be notified of larger defects and no repair welding of such defects shall be carried out without prior approval.
- G. If the removal of metal for repair will reduce the stress-resisting cross-section of the casting by more than 25%, or to such an extent that the computed stress in the remaining metal exceeds the allowable stress by more than 25%, then that casting may be rejected.
- H. Castings repaired by welding for major defects shall be stressed-relieved after such welding.
- I. Non-destructive tests will be required for any casting containing defects whose extent cannot otherwise be judge, or to determine that repair welds have been properly made.
- J. All major stress-bearing forgings shall be made to a standard specification that shall be submitted to the Engineer for approval before work is commenced. They shall be subject to internal examination and non-destructive tests for the detection of flaws and shall be heat-treated for the relief of residual stresses. The name of the maker and particulars of the heat treatment proposed for each such forging shall be submitted to the Engineer. The Engineer may arrange for such forgings to be inspected at the place of manufacture with a representative of the Contractor.
- K. Particular attention shall be paid to the prevention of corrosion due to the close proximity of dissimilar metals. Where it is necessary to use dissimilar metals in contact, they shall be selected so that the bimetallic corrosion is as low as possible. The publication by the UK H.M. Stationary Office entitled "Corrosion and its Prevention at Bimetallic Contacts" shall be used as a guide.

- L. The use of iron and steel shall be avoided in instruments and electrical relays wherever possible. Steel screws, when used, shall be zinc, cadmium or chromium plated or, when plating is not possible owing to tolerance limitations, shall be of corrosion resisting steel. All woodscrews shall be of dull nickel-plated brass or of other approved finish. Instrument screws (except those forming part of a magnetic circuit) shall be of brass or bronze. Spring shall be of non-rusting material, e.g., phosphor bronze or nickel silver, as far as possible. Pivots and other parts of which non-ferrous material is unsuitable shall be of approved rustless steel where possible.

#### 1.08 INSPECTION AND TESTS AT MANUFACTURER'S WORK

- A. The Engineer and his duly authorised representative shall have at all reasonable times access to the Contractor's premises to inspect and examine the materials and workmanship of mechanical equipment being manufactured there, and if part of such equipment is being manufactured on other premises, the Contractors shall obtain for the Engineer and for his duly authorised representative permission to inspect as if that equipment was manufactured on the Contractor's own premises. Such inspection, examination or testing, if made, shall not relieve the Contractor from any obligation under the Contract.
- B. All works, materials and the like rejected shall be corrected or replaced as necessary at the Contractor's own expense to the satisfaction of the Engineer.
- C. Where the mechanical equipment is composite unit of several individual pieces manufactured in different places, it shall be assembled and tested as one complete working unit, at the manufacturer's works, to the relevant test or tests required.
- D. The Contractor shall submit his proposed programme of tests for the Engineer' approval six weeks before the commencement of testing.
- E. The aforementioned works tests carried out before delivery to the Site shall not in any way relieve the Contractor of completing satisfactory Site tests after erection as specified.
- F. The Contractor shall give the Engineer reasonable notice, at least ten clear days in writing, of the date and the place at which any mechanical Equipment will be ready for testing as provided in the Contract and the Engineer shall thereupon at his discretion notify the Contractor of his intention either to release such part upon receipt of works tests certificates or of his intention to inspect such part. The Contractor shall forward to the Engineer six duly certified copies of all relevant test readings.
- G. The Contractor shall provide, free of charge, such labour, materials, electricity, fuel, water, stores, apparatus, instruments and other things as may be reasonably demanded to carry out efficiently such tests of the mechanical equipment in accordance with the Contract, and shall provide facilities to the Engineer or to his authorised representative to accomplish such testing. Where inspection or testing is to be carried out at a Sub-contractor's works, a representative of the Contractor shall be present.
- H. Works tests shall also be carried out such that due consideration is given to the Site conditions under which the mechanical equipment is required to function. The tests certificates shall give all details of such tests.
- I. Specific performance works tests are described in the relevant Sections of Division 15, and include:

- a) Sample performance testing of split units for airflow, heating and cooling & and noise emission.

#### 1.09 CERTIFIED DRAWINGS

- A. The Contractor shall be responsible for providing all "Certified" drawings from manufacturers of mechanical equipment, prior to their manufacture and installation. A "Certified" manufacturer's drawing shall mean a drawing which is prepared by a manufacturer as showing the exact dimensions and details of items of the mechanical equipment, as they will be supplied and installed in the Works.

#### 1.10 SAMPLES

- A. The Contractors shall provided a sample properly labelled of all fittings, valves, insulation, cocks, unions, grilles, dampers, switchgear, cables and other like accessories described in the Specification or as required by the Engineer.

#### 1.11 PROTECTION AND CARE OF PLANT AND EQUIPMENT

- A. All mechanical equipment shall be packed in robust containers to prevent damage and mishandling during transport to Site. Before dispatch from works all mechanical equipment shall be thoroughly cleaned, protected against damage, deterioration, corrosion and ingress of dirt, packed, and protected suitable for prolonged storage in a humid and saline atmosphere. During storage and erection at the Site, the mechanical equipment shall be kept clean and free from dirt and debris, and water shall not be allowed to remain in any pockets of the equipment. All items of mechanical equipment shall be stored clear to the ground on suitable timbers to the approval of the Engineer. All mechanical equipment, particularly electrical and other sensitive instrumentation shall at all times be protected so that it is not subject to damage by rainwater, moisture, dust, etc., from any source. Mechanical equipment, which may be damaged by heat or sun, shall be protected accordingly. All open piped ends and duct ends whether installed or in store shall be fitted with plastic caps or suitable protective covering.

#### 1.12 GUARDS

- A. A guard shall be provided for all open unprotected intakes to axial fans, centrifugal flow fans, for V-belt drives or in any position required by the UK Factories Act.

Fan guards shall be made of galvanized steel wire mesh, not greater than 25mm attached to a rigid galvanised steel rod framework. The fan maker shall manufacture the fan guards.

Cleaning: The Contractor shall be responsible for cleaning all mechanical equipment at all times to the satisfaction of the Engineer. The cleaning shall be carried out notwithstanding the fact that the installation or any part thereof may be in use of partial use within the premises in occupation by others. A Certificate of Completion will not be issued until the Engineer is satisfied that all dirt, jointing materials and other extraneous and injurious materials have been removed.

#### 1.13 AIR CONDITIONED STORES

- A. The Contractor shall provide air-conditioned site stores for all goods that deteriorate when subjected to the site climatic conditions detailed. The contractor will adhere

strictly to the Manufacturer's instructions with regard to storage temperatures for all materials being used for the construction of this project.

#### 1.14 PAINTING

- A. The preparation, painting and treatment of mechanical equipment surfaces shall be in accordance with relevant items in Division 15.
- B. Full details of the manufacturer's standard finishes shall be given to the Engineer for his approval prior to manufacturer. Special care shall be taken to ensure standard finishes are suitable for the particular conditions applicable to the individual items of plant.
- C. Any damage to paintwork occurs shall be made good by the Contractor at his own cost to the satisfaction of the Engineer.
- D. The interiors of control panels shall be finished white enamel paint (two coats) and shall comply with the appropriate BS for enamel finish and the exteriors of such panels shall be of BS Specification colour as specified by the Engineer to give a minimum reflection value of 42%. Instruments shall be finished dull black and control handles, push button and similar fittings shall be chromium plated or otherwise durably finished to the approval of the Engineer.
- E. All bright metal parts shall be covered before despatch with an approved protective compound and protected adequately during delivery to Site. After erection these parts shall be cleaned with a correct solvent and polished bright where required.
- F. Machined mating surfaces such as gear teeth, etc., shall be coated with a thick layer of grease. Other machined surfaces shall be given a coat of rust-preventing paint that shall be readily removable when required.
- G. Where it is the usual practice of the manufacturer of special items such as pumps, compressors, electric motors, gear boxes, switch gear, etc., to apply a high standard of protective enamel paintwork in the shops before despatch, this will be acceptable provided any subsequent damage to the paintwork is made good by the Contractor, at his own cost. The preferred finish is light grey.
- H. The inside of outdoor control cubicles, cabinets, etc., where condensation is liable to occur, shall be coated with an approved anti-condensation composition.
- I. The Contractor shall obtain the paint manufacturer's guarantee that each coat of paint is compatible with the previous and subsequent coats so that peeling, flaking and other faults do not occur.
- J. The Contractor shall include for painting all pipes, ducts, flange edges, etc., prior to their being insulated.
- K. Final decoration of exposed pipework, brackets and ductwork shall be carried out in accordance with standards.

#### 1.15 MANUFACTURER'S NAMEPLATES

- A. Nameplates: Each item of mechanical equipment and plant shall have the manufacturer's name or trademark on a corrosion-resistant nameplate securely affixed in a conspicuous place. The manufacturer's name or trademark may be cast integrally with stamped or otherwise permanently marked upon the item of the equipment. The nameplate shall show

the equipment reference number, date of manufacture and the capacity. Such other information as the manufacturer may consider necessary to complete identification shall be shown on the nameplates.

#### 1.16 LABELS

- A. Identification labels of plastic laminate or similar approved materials engraved black on white unless otherwise agreed, with not less than 5mm "line" style letters shall be fixed on or adjacent to all controls, switches and distribution gear, by means of at least two brass screws. Socket outlets of all voltages shall be similarly identified or engraved.
- B. The labels shall bear the identification shown on the Drawings, such as indication, designation, function and, where necessary, phase, voltage, current, frequency, pressure and temperature. All labels shall be in Arabic and English.

#### 1.17 LUBRICATION

- A. The Contractor shall furnish a complete schedule of recommended oils and other lubricants. The number of different types of lubricants shall be kept to a minimum. The schedule and the name of the supplier of the lubricants shall be submitted to the Engineer for approval before incorporation in the instruction manuals. In the case of grease lubricated roller type bearings for electric motors, lithium base grease is preferred.
- B. Where lubrication is affected by means of grease, preference shall be given to a pressure system, which does not require frequent adjustment or recharging. Frequent for this purpose, means more than once weekly and grease systems having shorter periods between greasing should be avoided. Where necessary for accessibility, grease nipples shall be placed at the end of extension piping and, when a number of such points can be grouped conveniently, the nipples shall be brought to a battery plate mounted in a convenient position. Button head type nipples shall be of the same size and type for every part of the plant. Arrangements shall be provided to prevent bearings being overfilled with either grease or oil
- C. Where more than one special grease is required a grease gun for each special type shall be supplied and permanently labelled.
- D. Oil sumps shall be fitted with oil level indicators of the sight glass type, or where this is not practical, with dipsticks. The indicators shall show the level of all temperatures likely to be experienced in service. The normal, maximum and minimum levels at 30°C shall be clearly visible in the sight glass type from the normal access floor to the particular item of plant, and they shall be easily dismantled.
- E. All sight glasses shall be firmly held and enclosed in metal protection in such a manner that they cannot be accidentally damaged.
- F. All lubrication systems shall be designed so as not to present a fire hazard and particular care shall be taken to prevent leakage of lubricants and to avoid leaking lubricants coming into current contact with any electrical equipment, heated surfaces or any other potential source of fire.
- G. The Contractor shall supply flushing oil for each lubrication system when an item of plant is ready for preliminary running and a sufficient quantity of the approved lubricants for setting to work and for the commercial operation for one year after the relevant Certification of Completion has been issued.

1.18 SPECIAL TOOLS

- A. The Contractor shall supply two complete sets of any special tools necessary for the operation, maintenance and dismantling of the mechanical equipment. The Contractor shall supply wall-mounted strongboxes, each fitted with a suitable lock and two keys, and located near the item of mechanical equipment for which they will be used. The Contractor shall not use such tools during the erection of the mechanical equipment.

1.19 SUNDRY BUILDERS WORK IN CONNECTION WITH SERVICES

- A. The Contractor shall include in his prices for drilling, rawbolting, plugging, screwing and nailing of all brackets, hangers, for all pipework, ductwork conduit, cable tray, cable trunking and cable supports. The Contractor shall also include for supplying all brackets, hangers and supports as necessary.

1.20 NOISE

- A. The Contractor shall provide a quiet installation. All items of mechanical equipment shown on the Drawings shall be carefully chosen with a view to silent operation. The recommendations in BS 5720 and BSCP 3 Chapter III shall be followed wherever necessary. The Contractor shall prepare detailed noise level calculations to indicate the anticipated noise levels in all critical areas.
- B. All possible steps shall be taken, (e.g. by the use of sound insulation, anti-vibration mountings, and careful design of motors, fans, ducts, bends, dampers, grilles and other equipment) to reduce the noise produced by the mechanical equipment.
- C. The Contractor shall determine the noise levels of all primary mechanical equipments before proceeding with manufacture and submit sound power levels of such Equipment to the Engineer for approval before manufacture is commenced.

1.21 ANTI-VIBRATION MOUNTINGS AND SOUND ABSORPTION

- A. The Contractor shall provide and fix all mechanical equipment to prevent noise and the transmission of vibration through the structures.
- B. All fans, motors, compressors and other items, as appropriate, shall be mounted on resilient mountings in such a manner that the plant foundations are isolated from the floor or structure. In addition, all rotating plant shall be statically and dynamically balanced.
- C. Mechanical vibration shall be eliminated by the use of anti-vibration mountings and flexible connections to ensure an isolation efficiency of 95% from the building structure except where defined otherwise on the Drawings or in the Specification.
- D. Spring type anti-vibration mountings shall be the captive partially encased and restrained type to prevent lateral movement.

1.22 AS BUILT DRAWINGS

- A. Thirty days prior to the date of the handing over certificate, the Contractor shall provide for approval "as built" record drawings of the whole works.
- B. The Drawings shall include the following:-
  - 1. General arrangements of all services to a scale of not less than 1:50.



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2. Detailed layouts of plantrooms and similar spaces to a scale of not less than 1:20.
  3. Schedules of all plant and crossed referenced equipment to the maintenance manual.
  4. All equipment and control wiring diagrams together with specialist system i.e. public address, fire alarms, etc.
  5. These may be produced separately or included with the general distribution diagrams.
  6. Indicate with accurate dimensions, sizes and positions of all plant, equipment and valves together with all inspection points and test positions. All plants to have indicated manufacturer's name, model and type number also cross referenced to maintenance manual.
  7. Fully indicate all ductwork, pipework, sizes and positions of all plant equipment and valves together with all inspection points and test positions. All plant to have indicated manufacturer's name model and type number also cross referenced to maintenance manual.
  8. Show the disposition and depth of all cables, pipes, ducts, buried direct in the ground and taken at intervals where cable increase or decrease in number/size and at every point where the services enter into or depart from ducts or buildings.
  9. Indicate the number, sizes and services for every cable, duct, pipe, for every service within each building. Circuit lists for every distribution board shall be entered on to the relevant drawings and such lists shall agree with the list fixed within the distribution board door.
  10. Show clearly on site drawings all the new buildings together with all other existing buildings and other permanent features with dimensions between such buildings and cables, pipes, ducts, etc. clearly marked, together with installed backfill and surround to each services.
  11. Indicate all equipment and control wiring diagrams together with all specialist systems i.e. public address, fire alarm, etc. Diagrams must be co-ordinated and show all required interblocks etc. between systems or components.
  12. Show clearly all plumbing and drainage and setting out dimensions for all drainage pipework and manholes both within the building throughout the site, together with drainage pipework backfill, or surround in each location. A schedule shall be included to indicate each manhole size, cover size, invert level and ground level.
- C. The symbol used for each service for all as built drawings shall be shown on separate drawings.

- D. In order to achieved accurate as built drawings, all relevant information relating to the mechanical works shall be entered onto prints supplied immediately after the work has been carried out. The marked up prints shall be available for inspection at the Contractor's site office at any reasonable time during the progress of the works.
- E. All service routes, intersections and joints shown on the prints and finally recorded shall be actually physically measured from permanent features and accurate distances shall be shown on the Drawings.
- F. In addition to the as built drawings, the Contractor shall obtain and provide two sets of all manufacturer's detailed drawings for all items of plant, equipment, apparatus and materials. These drawings shall be suitably titled and have drawing reference numbers added.
- G. The Contractor shall provide two copies for all as built drawings for review comments and approval. Upon receiving approval in writing from the Engineer, or his representative, the Contractor shall provide one negative copy of each approved as built drawing and bind one set of prints into each of 6 No. copies of the operating instructions specified in clause 1.23.

#### 1.23 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. The working, operating and maintenance instruction shall be prepared in draft as soon as the working drawings are in hand and shall take the form of a manual in which fully detailed information relating to the maintenance and operation of the complete installation and its component parts is presented.
  - a) Overall general description of the complete equipment installed together with the method of functioning.
  - b) Full technical descriptions of each and every item of equipment, including the electrical circuit details as applicable.
  - c) Operating procedures for each section of the works and each individual item of equipment or plant.
  - d) Planned maintenance schedules for the installation and its component parts to include commissioning performance details and measurements.
  - e) Schedule of components comprising each and every item of equipment including manufacturer's name, description and part number of each component.
  - f) A copy of the manufacturer's literature, describing each item of equipment, plant fittings and accessory type used throughout the installation. This literature shall list the technical data available, together with catalogue list numbers for replacement purposes.
  - g) Generally all drawings must be arranged to flood out from their position and be entirely visible when any part of the manual is being read. They shall be printed on linen backed paper.
  - h) Each section shall be encased in a loose leaf ring binder covered in plastic material of an approved colour and of a type which shall be flat when open.

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- i) The Contractor shall include for the preparation and supply of six copies of the above operating and maintenance instructions for each section after all details have been approved by the Engineer.
- j) Electric transfer of "As Built" drawings shall be provided as required by the Engineer.

### 1.24 INSTRUCTION AND TRAINING

The Contractor shall be responsible for the provision of suitably qualified personnel for the instruction and supervision of the Employer's staff at Site in the operation and routine maintenance of all mechanical equipment and associate works. Unless specified to the contrary in the specific technical clauses in Division 15 instruction and training shall be for periods of six hours daily for two days after the satisfactory commissioning of the installation and as necessary, after each subsequent commissioning of a system or part thereof.

### 1.25 SPARES AND CONSUMABLES

- A. A list of spares and consumables for 1 years operation for every item of plant and system shall be furnished by the Contractor at the time of tendering.

### 1.26 MOCK-UPS

- A. The Contractor shall provide mechanical equipment to allow full Architectural Mock-ups to be built as described elsewhere in the specification.

## **PART 2 PRODUCTS**

2.01 Not Used.

## **PART 3 EXECUTION**

3.01 Not Used.

END OF SECTION 15010

## SECTION 15171

### ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

#### PART 1 GENERAL

##### 1.01 SCOPE OF SECTION

- A. This Technical Specification details the electrical requirements of the mechanical equipment and plant.
- B. All electrical materials, equipment, plant and installation procedures shall be in accordance with Division 16 of this Specification.

##### 1.02 WORK INCLUDED

- A. The work includes the provision of all labour materials and the performance of all operations in connection with the electrical requirements for mechanical equipment.
- B. Co-ordination: The Contractor shall be responsible for the full co-ordination of the work of all trades.

##### 1.03 QUALITY ASSURANCE

- A. The Contractor shall employ specialist electrical equipment installers and manufacturers that can demonstrate at least 5 years successful experience in the supply and installation of the type of equipment and systems specified.

##### 1.04 APPLICABLE CODES AND STANDARDS

- A. The Electrical Requirements shall comply with the latest relevant British Standards in all respects.
- B. The following are some of the most commonly used British and other Standards associated with Electrical works. However, the Contractor shall ensure all applicable Standards are complied with, whether listed here or not.

BS 1376	-	Specification for colours of light signals.
BS 2757	-	Method for determining the thermal classification of electrical insulation.
BS 4099	-	Colours of indicator lights, push buttons, annunciators and digital readouts.
BS 4794	-	Special requirements for specific types of control
Part 2		switches.
BS 6231	-	Specification for PVC insulated cable for switchgear and controlgear wiring.
IEC 144	-	Degrees of protection of enclosures for low voltage switchgear & controlgear.

##### 1.05 SUBMITTALS

- A. Drawings refer to 15010

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- B. Product data - relating to each and every component and assembly.
- C. Systems information - full schematic and wiring diagrams including panel fascia layouts.

### 1.06 OPERATION AND MAINTENANCE DATA

- A. Comply with 15010

### 1.07 WARRANTY

- A. Provide 12 months warranty in accordance with contract conditions.

### 1.08 EXTRA MATERIALS

- A. Comply Section 15010.

## PART 2 PRODUCTS

### 2.01 CONTROL PANEL ENCLOSURES

- A. Panels shall be constructed from 2 mm thick galvanised steel plate to IP54.
- B. Each composite panel shall include a main isolator interlocked with the door that shall be lockable. All panels shall be finished with stove enamel internally and externally. All panels shall be sealed against ingress of moisture, dust and vermin. All starters and controls shall be located in panels unless agreed otherwise by the Engineer.
- C. An earthing bar shall be provided throughout the entire length of the control panel.
- D. A minimum of 2 doors shall be provided on any panels wider than 800 mm that shall be fabricated to form rigid trays with dust excluding gaskets around their perimeter.

Doors shall be filled with hinges to facilitate the removal of the door panels if required.

All doors shall be interlocked or arranged such that the door that provides access to the main isolator must be opened first. All door locks shall be provided with common keys.

### 2.02 CONTROL SWITCHES AND ELECTRICAL ISOLATION

- A. Control switches shall comply with BS 4794.
- B. Switches shall be of the rotary type.
- C. All control switches shall be capable of being locked in the "off" position, unless stated otherwise.
- D. The contacts of all switches shall be strong and have a positive wiping action when operated.
- E. All control switches shall be provided with labels.
- F. All control panels shall be provided with a defeat proof door interlock isolator controlling the main incoming supply. The isolator shall be capable of making and breaking on full load without damage. Additionally the isolator shall have:-
  - a) Auxiliary contacts to isolate any secondary supplies to the control panel.

- b) Manual override switch to enable the control system only to be energised whilst the incoming supplies are isolated.

All terminals of the isolator (incoming and outgoing) are to be shrouded to prevent accidental contact.

- G. The panel shall be constructed such that power (3 phase and single phase) equipment is located behind the interlocked isolator door.

Control (extra low voltage) equipment shall be located behind the second or subsequent doors to ensure segregation from power equipment.

The control system operating voltage shall not exceed 220V without prior authorisation.

All internal wiring shall be enclosed within wireways. Inter wiring that is required to pass between the power and control sections of the panel shall be enclosed within separate or segregated wireways to ensure electrical separation of the power and control systems.

### 2.03 INDICATING LAMPS INSTRUMENTS AND FITTINGS

- A. Indicating lamps fitted into the facias of switch and instrument cubicles or panels shall be adequately ventilated.
- B. A red warning light shall be provided to indicate "Main Supply On".
- C. The following must be included on all local HVAC control panels (EMCP's and MCP's).
  - a) Run/trip lamps for all equipment to prevent accidental contact.
- D. The following must be included on all local HVAC control panels (EMCP's and MCP's).
  - a) Run/trip lamps for all equipment
  - b) Panel live lamp
  - c) Rotary switches for all single plant items
  - d) Ammeters for all motors.
  - e) Warning lamps
  - f) Gauges
  - g) Filter clogged indicator lamp.
- E. Lamps shall be easily replaceable from the front of the panel by manual means without the use of extractors.
- F. The bezel of metal or other approved material holding the lamp glass shall be of an approved finish and easily removable from the body of the fitting so as to permit access to the lamp and lamp glass.
- G. The lamps shall be clear and shall fit into a standard form of lamp holder. The rated lamp voltage should be 10 percent in excess of the auxiliary supply voltage, whether ac or dc.
- H. The lamp glasses shall comply with BS 1376 and BS 4099 and shall be in standard colours, red, green, blue, white and amber. The colour shall be in the glasses and not an applied coating and the different coloured glasses shall not be interchangeable.

Transparent synthetic materials may be used instead of glass, provided such materials have fast colours and are completely suitable for use in tropical climates.

- I. All indicating 1 Amp circuits shall have a "Test Lamp" switch.

#### 2.04 SMALL WIRING

- A. All control panel wiring shall be carried out in a neat and systematic manner with cable supported clear of the panels and other surfaces at all points to obtain free circulation of air.
- B. In all cases, the sequences of the wiring terminals shall be such that the junction between multi-core cables and the terminals is affected without crossover. Except where terminals are approved by the Engineer for use with bare conductors, crimped connectors of approved type shall be used to terminate all small wiring. Insulating bushes shall be provided where necessary to prevent chafing of wiring.
- C. All panel wiring shall comply with the requirements of BS 6231 Type A or B, as appropriate. Conductors shall be copper and have a minimum cross section equivalent to 50/0.25 mm (2.5 mm<sup>2</sup>), 7/0.67 mm (2.5 mm<sup>2</sup>) or 1/1.78 mm (2.5 mm<sup>2</sup>). 7/0.67 mm shall only be employed for rigid connections which are not subject to movement or vibration during shipment, operation or maintenance. Flexible conductors equivalent to 30/0.25 mm (1.5 mm<sup>2</sup>) or smaller sizes generally shall only be employed with written approval.
- D. All wires shall be colour coded and fitted with numbered ferrules of approved type at each termination. At points of inter-connection between wiring, where a change of numbering cannot be avoided, double ferrules shall be provided. Such points shall be clearly indicated on the wiring diagram.
- E. No wires shall be teed or jointed between terminal points.
- F. Electrical wiring and instruments shall be located so that leakage of oil or water cannot affect them.
- H. All metallic cases of instruments, control switches, relays etc., mounted on control panels or in cubicles, steel, or otherwise, shall be connected by means of copper conductors of not less than 2.5 sq.mm section to the nearest earth bar. These conductors may be bare or have insulation coloured green/yellow stripes.

#### 2.05 LINKS AND FUSES

- A. Provision shall be made for isolating links to enable circuits to be isolated for maintenance and testing items of plant on the panels without affecting other circuits. These links shall be clearly labelled.
- B. All incoming supply terminals above 220V shall be shrouded.
- C. Fuses of the appropriate rating shall be fitted to each outgoing circuit to provide both overload and short-circuit protection.
- D. All fuses shall be of the HRC cartridge type and comply with BS 88. Carriers and bases for fuses and links shall be coloured in accordance with local practice. The labelling of links and fuses shall be in accordance with the schematic diagrams. A complete set of spare fuses shall be provided in each panel.
- E. If miniature circuit breakers and/or moulded case circuit breakers are utilised in any circuit, and "back-up protection is required to afford adequate discrimination between these circuit breakers and any other protective device in the circuit, HRC fuses shall be used as "fault current limiters".

- F. The rating and characteristics of fault current limiters shall be such as to limit the fault current of the ultimate circuit breaker in the circuit to the fault current capacity of the circuit breaker. Fault current limiters shall be such that they will not operate under overload as distinct from short circuit conditions. Fault current limiters shall be labelled as such.
- G. Equipment fixed inside cubicles shall be required to give easy access to wiring and terminals. Resistance boxes shall be located so that the adjustment screws are on a vertical accessible face. Stud terminals shall be provided for all resistances.

## 2.06 TERMINAL BOARDS

- A. Grouped terminal boards of adequate capacity and fully numbered, with permanent labels, shall be provided for all wires leading to equipment outside a panel. Terminal numbers or markings shall correspond with those used on related apparatus and wiring diagrams. Removable plates or other facility shall be provided for the entry of incoming cables, conduits, trunking, etc. with means for effective earthing to the cubicle chassis. Provision shall be made for the earthing of all non current-carrying metalwork. For main power terminals incorporated within a panel, soldered socket type terminals shall be provided.
- B. All terminal boards shall be mounted in accessible positions and when in enclosed cubicles, are preferably to be inclined towards the doors. Spacing of adjacent terminal boards shall be not less than 100 mm and the bottom of each board shall be not less than 200 mm above the incoming cable gland plate. Separate terminations shall be provided on each terminal strip for the cores of incoming and outgoing cables including all spare cores. Barriers shall be provided between wires of different voltages on the same or adjacent terminals.
- C. Terminals that are "live" from other power sources when the cubicle isolator is open shall be shrouded and fitted with a danger label.
- D. Screw or stud type terminals shall only be used with crimped ring type wiring terminations. Plain steel screws and studs shall be not less than size M6 but stainless steel and bronze down to size M5 may be used provided that the current carrying capacity is adequate. All studs shall be provided with nuts, washers and lock washers.
- E. Insertion type terminals shall generally be employed for small circuit wiring whereby the stranded conductor or crimped termination is clamped between plates by a screw having a suitable locking device. Terminal entries shall be shrouded such that no current carrying metal is exposed. Tapped holes shall have not less than three full threads.
- F. Terminal assemblies are preferably to be of the unit form suitable for mounting collectively on a standard assembly rail, secured from the front and giving the required number of ways plus 10% spare.
- G. All connections shall be made at the front of the terminal boards and no live metal is to be exposed at the back.
- H. No more than two leads shall be taken to any common pair of terminals, unless specially approved by the Engineer.

## 2.07 NUMBER PLATES AND LABELS

- A. Number plates and labels shall be provided and fixed to all items, including push buttons, operating levers, indicating lamps, etc. to show the purpose and function of each item and to ensure its safe and satisfactory operation. The type, size, inscription and position of labels shall be to the Engineer's approval.



- B. Adhesive die stamped or printed tapes shall not be permitted for labelling equipment.

#### 2.08 EARTHING

- A. All control panels shall be provided with a continuous copper earth bar having a sectional area of not less than 75 mm<sup>2</sup> placed at a convenient position near the bottom of the panel. The area of the earth bar shall not be less than half the cross-sectional area of the phase busbars and not less than the area of the incoming neutral conductor.
- B. All metal cases or earth terminals of the various instruments, relays, etc. on the panels shall be connected to this earth bar by copper connections of not less than 2.5 mm<sup>2</sup>.
- C. All metal parts other than those forming part of any electrical circuit shall be earthed in an approved manner and all earthing terminals shall be of adequate dimensions.

#### 2.09 ANTI CONDENSATION HEATERS

- A. Anti-condensation heaters shall be provided in all control panels, switchboards and motors to prevent internal condensation due to atmospheric or load variations. The heaters shall be thermostatically controlled and of sufficient capacity to maintain 5°C temperature differential with the surrounding atmosphere. The heater circuit shall include an isolating switch and indicator lamp to show "Heater Circuit On". The heaters may be energized from a 220V, 50Hz supply, as applicable.
- B. When maintaining equipment fitted with heaters it will be necessary to switch off both the main isolating switch and the switch for the heater. A warning notice of this danger shall be fitted near the terminal box of every remote heater and at every panel fitted with heaters.
- C. All equipment fitted with heaters shall be such that the maximum permitted rise in temperature is not exceeded if the heaters are energized while the equipment is in operation and as such must be provided with suitable ventilation.
- D. All such equipment, whether fitted with a heater device or not, shall be provided with suitable drainage and be free from pockets in which moisture can collect.

#### 2.10 MOTOR STARTERS

- A. Motor starter enclosures shall be at least to the standards specified for LV switchgear.
- B. Motor starters shall be of the following types and suitably rated for each application:-

MANUAL	= UNDER 0.34 KW MOTORS
DIRECT ON LINE	= UP TO 5 KW MOTORS
STAR DELTA	= ABOVE 5 KW MOTORS

AUTO TRANSFORMER WHEN SUPPLIED BY THE MOTOR MANUFACTURER.

- C. Auto-transformer type motor starters when supplied shall each comprise:
  1. Triple pole mechanically interlocked isolator with padlocking facilities in the 'off' position.
  2. H.R.C fuses in the power circuit.
  3. Adequately rated autotransformer.

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4. Contractors rated at 15 starts per hour suitable for pushbutton operation, with magnetic blowouts and arc chutes on each pole, hard drawn copper main contacts of the removable type, and continuously rated operating coils.
  5. Under voltage release.
  6. Overload relays of the adjustable electro-magnetic type with oil dashpot time lags and reset facilities, calibrating plates shall be scaled in amperes or equivalent thermal compensated type.
  7. Control circuit fuses of the cartridge type.
  8. Single phase preventative device.
  9. Ammeter of the moving iron type.
  10. Pilot lamp to indicate "motor-running".
  11. Removable neutral link of heavy section copper.
- D. The Star/Delta motor starters shall each comprise:
1. Triple pole mechanically interlocked isolator with padlocking facilities in the "off" position.
  2. H.R.C. fuses in the power circuit.
  3. Contractors rated at 15 start per hour suitable for pushbutton operation, with magnetic blowouts and arc chutes on each pole, hard drawn copper main contacts of the removable type and continuously rated operating coils.
  4. Under voltage release.
  5. Overload relay of the adjustable thermal type.
  6. Control circuit fuses of the cartridge type.
  7. Motor protection relay (unbalance and single phasing)
  8. Ammeter of the moving iron type.
  9. Pilot lamp to indicate "motor running".
  10. Removable neutral link of heavy section copper.
- E. Direct-on-line type motor starters shall each comprise:
1. Triple pole mechanically interlocked isolator with padlocking facilities in the "off" position.
  2. H.R.C. fuses in the power circuit.
  3. Contractor rated at 15 starts per hour suitable for pushbutton operation, with magnetic blowouts and arc chutes on each pole, hard drawn copper main contacts of the removable type, and continuously rated operating coils.
  4. Under voltage release.
  5. Overload relays of the adjustable thermal type.

6. Control circuit fuses of the cartridge type.
  7. Motor protection relay (unbalance and single phasing).
  8. Ammeter of the moving iron type for motors in excess of 5 Kw.
  9. Pilot lamp to indicate "motor running".
  10. Removable neutral link of heavy section copper.
- F. For starters incorporating reduced voltage starting the change over shall be automatic. A lock-off switch shall be provided and located locally to each motor and connected into the starter control circuit so that the starter cannot be operated when the switch is in the "off" position.
- G. "Hand/off/Auto" switches shall be provided for all starters.

#### 2.11 ELECTRIC MOTORS

- A. Motors shall be of the totally enclosed fan cooled (TEFC) design to BS 5000 and shall be fitted with axially locating type bearings and/or heavy duty thrust bearings at the non-driving end and roller type bearings at the drive end. All bearings shall be of adequate proportions and design suitable for the particular application.
- B. Motors shall be of the squirrel cage induction type. Motors shall be suitably finished to afford protection against any corrosive liquid or fumes.
- C. All motors shall be built of high-grade components and materials and shall operate without undue vibration and with the minimum of noise.
- D. The insulation shall be Class 'F' to BS 2757 but the temperature rise shall be limited to 80 °C measured by the resistance method, at an ambient temperature of 50 °C. The motors shall be suitable in all respects for their operational duties taking into account such an ambient temperature within the building.
- E. All motors rated at 11 KW and above shall be fitted with thermostatic control elements actuating directly on the control circuit of the motor and disconnecting it from the supply in the event of a temperature rise exceeding the acceptable limits for its insulation class.
- F. The motors shall be fully tropicalised, and shall be fitted with anti-condensation heaters.
- G. The motors shall be capable of providing 10% in excess of the specified volume flow of their respective fans under all operating conditions. Selections must assume that resistance increases by the square law and absorbed power by the cube law.
- H. Motors are required to operate from a 380V, 3 phase or 220V single phase, 50Hz supply as applicable, and shall be continuously rated.
- J. The motors shall be capable of satisfactory operation with a voltage variation of 10% above or below the supply voltage. They shall also be capable of operating satisfactorily with a frequency variation of 2.5% above or below the normal frequency of 50 Hz, as applicable.
1. No motor shall run faster than 1500 RPM unless otherwise approved by the Engineer.
  2. Motors shall be designed to operate at a power factor not less than 0.85.

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3. Motors shall be suitable for the starting methods specified.
4. Motor starting currents shall not exceed the following values:-
  - Autotransformer starting - 1.5 times the full load current.
  - Star/Delta starting - 3.5 times the full load current.
  - Direct-on-line starting - 6 times the full load current.
- K. The connections of the motors shall be brought out to easily accessible terminals of the stud type, totally enclosed. They shall be substantially designed and thoroughly insulated from the frame. Cambric or equal insulation shall be used for the connections from the windings to the terminals. Terminal boxes shall be fitted with glands to accept the specified type of cable.
- L. The cable glands shall be downward pointing at such an angle as is necessary to clear the motor base plate and plinth.
- M. Motors shall have visible nameplates indicating:-
  - Motor power --- KW
  - Voltage
  - Phase
  - Cycles
  - RPM
  - Full load amps,
  - Locked Rotar amps
  - Frame size
  - Manufacturers name and model
  - Power factor

### **PART 3 EXECUTION**

#### 3.01 INSTALLATION

- A. Installation of all the equipment, plant and material included in this Section of the Specification shall additionally be in accordance with the requirements of Division 16.

END OF SECTION 15171

## SECTION 15190

### MECHANICAL IDENTIFICATION

#### PART 1 GENERAL

##### 1.01 SCOPE OF SECTION

- A. This Technical Specification establishes the type and quality of materials and the standard of workmanship to be used in the supply and installation of Mechanical Identification systems.

##### 1.02 WORK INCLUDED

- A. The work includes the provision of all labour, materials and the performance of all operations in connection with the supply and installation of Mechanical Identification systems as specified herein and where referred to on the Drawings.
- B. Coordination: The Contractor shall be responsible for the full coordination of the work of all trades.

##### 1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of Mechanical Identification systems whose products have been in satisfactory use for a similar application and not less than 10 years.
- B. Installer: Firms regularly engaged and qualified in the installation of Mechanical Identification systems with at least 5 years successful installation experiences on projects of a similar nature.

##### 1.04 APPLICABLE CODES AND STANDARDS

- A. Mechanical Identification systems and all associated materials and workmanship shall comply fully with the latest relevant British Standards in all respects.

The following are the most commonly used and relevant British Standards associated with pipe work products and associated materials. However, the Contractor shall ensure that all applicable British Standards are complied with whether listed here or not.

- BS 1710 - Specification for Identification of Pipelines and Services.
- BS 4800 - Specification for Paint Colours for Building Purposes.

##### 1.05 SUBMITTALS

- A. Drawings refer to 15010
- B. Products: Full manufacturers colour data for each product.

- C. Samples - Full - size colour sample of pipe work and ductwork identification.

1.06 OPERATION AND MAINTENANCE DATA

- A. Comply with 15010
- B. Mechanical identification system shall correspond totally to "As Built" data.

1.07 WARRANTY

- A. Provide 12 months warranty in accordance with contract conditions.

**PART 2 PRODUCTS**

2.01 PLANT AND PIPEWORK IDENTIFICATION

- A. All pipe work shall be colour coded in accordance with BS 1710 as detailed in Table 1.

TABLE I

IDENTIFICATION OF PIPELINES

Pipe contents	Colour code indication (approx 100mm)	Basic colour (approx 150mm)
Drinking Water	To BS 1710	Blue
Cold water down service	To BS 1710	Green
Hot water supply	To BS 1710	Green
Drainage	To BS 1710	Black
Heating pipes	To BS 1710	Green
Diesel Fuel	To BS 1710	Brown

- B. Identification to pipe work shall consist of 100mm PVC adhesive bands over the basic colour and shall include flow direction arrows together with the abbreviation of the service name. All coding requirements are to be agreed with the Engineer.

- C. Code indication for safety conditions shall be as follows:-

Safety Colour	BS colour reference
	BS 4800
Red	04 E 53
Yellow	08 E 51
Auxiliary Blue	18 E 53

Safety colour references are as follows: -

1. Red for fighting equipment.
2. Yellow with black diagonal stripes for warning of danger.
3. Yellow with trefoil symbol for ironizing radiation (as defined in BS 3510).

4. Auxiliary blue in connection with green basic colours, to denote pipes carrying fresh water, either potable or non-potable.

Safety colour references shall be applied using 100mm wide sections of PVC adhesive band in all permanent locations, to be agreed with the Engineer.

Colour references shall include notation as follows:-

1. FIRE
2. DANGER
3. RADIATION
4. POTABLE OR NON-POTABLE

In the case of fire service, all equipment, i.e. valves, suction tanks, etc., shall also be painted red.

- D. Un insulated pipe work shall be painted with one coat of undercoat and two coats of gloss finish to the relevant BS colour.
- E. Valve identification shall be by means of 40mm diameter traffalyte discs of white/black/white composition. Letters and figures of 8mm minimum height, identifying the service and valve number shall be engraved into the material. A 3mm diameter hole shall be drilled through the disc for the purpose of securing the disc to the valve.
- F. Plant identification shall be by means of traffalyte labels of white/black/white composition. Letters and figures of 8mm minimum height identifying the plant shall be of a size to be agreed with the Engineer. A minimum of two 3mm diameter holes shall be drilled through the label to the plant.
- G. All plants shall carry the manufacturer's identification plate which shall incorporate all details of electrical and mechanical duties.

## 2.02 DUCTWORK IDENTIFICATION

- A. Ductwork shall be colour coded in accordance with HVAC Specification DW142 to the colours indicated in Table 2. For conditioned air, identification shall comprise either of two symbols (one red, one blue) or a single symbol coloured, part red, part blue.

TABLE 2

DUCT IDENTIFICATION COLOURS

BS 4800	Colour	Type
04353 / 18E53	Red and Blue	Conditioned Air
10E53	Yellow	Warm Air
14E53	Green	Fresh Air
AA009	Grey	Exhaust / extract recirculated air
06C39	Brown	Foul Air

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- B. Direction of flow shall be by PVC self adhesive equilateral triangles with one apex pointing in the direction of flow. The minimum length of side of the triangle shall be 150mm.

**PART 3 EXECUTION**

**3.01 STORAGE**

- A. All identification materials shall be stored within a well lit container or purpose made compartmented racks or shelving. The material shall be adequately covered to prevent damage and ingress of dirt.

**3.02 GENERAL**

- A. Identification shall be placed where it can be easily seen and at positions where identification will be required. To ensure that the symbols are seen, the following points shall be considered:-

1. The symbols shall be on the surface which faces the positions of normal access to the completed installation.
2. The symbols shall not be hidden from view by structural members, other ducts, plant or other services distribution systems.
3. The symbols shall be placed where there is adequate natural or artificial light.

- B. Symbols shall occur frequently enough to avoid the need for ducts and pipes to be traced back. Symbols should be placed at any service and access points to the distribution system.

- C. Identification shall be applied to pipe work and ductwork at every entry and exit point to a room but in no case of intervals of less than 12m.

**3.03 PLANT AND PIPEWORK IDENTIFICATION**

- A. In addition to the colour bands, all pipe work in plant rooms and service areas, whether insulated or not, shall be legibly marked with black or white letters to indicate the type of service and the direction of flow. Services shall be identified as follows:-

Refrigerant:		RFG
Cold Water:	Raw	CRW
	Sweet	CWS
Domestic Hot Water:	Raw	HWS
Fire Main:		FM
Heating:		HTG

- B. The basic identification colour shall be applied using PVC adhesive band either applied to pipe work insulation or pipe when un-insulated. Identification shall be placed at all



junctions, at both sides of valves, services appliances, bulkheads, wall penetrations and at any other places where identification is necessary or advantageous.

- C. Where pipes are run in pairs, the letters F and R shall be added to indicate flow and return respectively.

### 3.04 DUCTWORK IDENTIFICATION

- A. All ductwork in plant rooms and services areas, whether insulated or not, shall be legibly marked with black or white letters to indicated the type of service and the direction of flow. Services shall be identified as follows:-

Supply Air	-	S
Return Air	-	R
Fresh Air	-	F
Exhaust	-	E

- B. Ductwork identification shall be applied to ductwork whether insulated or not, at all branches, plant connections, wall penetrations and at any other place where identification is necessary or advantageous.

END OF SECTION 15190

**SECTION 15210**

**EQUIPMENT BASES, SUPPORTS AND VIBRATION ISOLATION**

**PART 1 DESCRIPTION**

1.01 SCOPE OF SECTION

This Technical Specification establishes the type and quality of materials and the standard of workmanship to be used in the supply and installation of Supports and vibration isolators for mechanical equipment.

1.02 WORK INCLUDED

- A. The work includes the provision of all labour, materials and the performance of all operations in connection with the supply and installation of Supports and vibration isolators for mechanical equipment as specified herein and where referred to on the Drawings.
- B. Coordination: The Contractor shall be responsible for the full coordination of the work of all trades.

1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of Mechanical Identification systems whose products have been in satisfactory use for a similar application and not less than 10 years.
- B. Installer: Firms regularly engaged and qualified in the installation of Mechanical Identification systems with at least 5 years successful installation experiences on projects of a similar nature.

1.04 APPLICABLE CODES AND STANDARDS

Supports and vibration isolators for mechanical equipment and all associated materials and workmanship shall comply fully with the latest relevant British Standards in all respects in addition to the following American standards:

- A. Air Movement and Control Association International, Inc.:
  - 1. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
- B. American National Standards Institute:
  - 1. ANSI S1.4 - Sound Level Meters.
  - 2. ANSI S1.8 - Reference Quantities for Acoustical Levels.
  - 3. ANSI S1.13 - Methods for the Measurement of Sound Pressure Levels in Air.
  - 4. ANSI S12.36 - Survey Methods for the Determination of Sound Power Levels of Noise Sources.
- C. Air-Conditioning and Refrigeration Institute:
  - 1. ARI 575 - Method of Measuring Machinery Sound within Equipment Space.
- D. American Society of Heating, Refrigerating and:
  - 1. ASHRAE 68 - Laboratory Method of Testing In-Duct Sound Power Measurement Procedure for Fans.
  - 2. ASHRAE Handbook - HVAC Applications.

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- E. ASTM International:
  - 1. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
  - 2. ASTM E477 - Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
  - 3. ASTM E596 - Standard Test Method for Laboratory Measurement of the Noise Reduction of Sound-Isolating Enclosures.
- F. Sheet Metal and Air Conditioning Contractors':
  - 1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

### 1.05 SUBMITTALS

- A. Drawings: refer to 15010
- B. Products: Full manufacturers colour data for each product.
- C. Samples - Full - size Supports and vibration isolators for mechanical equipment.

### 1.06 OPERATION AND MAINTENANCE DATA

- A. Comply with 15010
- B. Supports and vibration isolators for mechanical equipment shall correspond totally to "As Built" data.

### 1.07 WARRANTY

Provide 12 months warranty in accordance with contract conditions.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

Subject to compliance with requirements, manufacturers offering products which may be incorporated in the Work shall conform to the required performance:

### 2.02 CONCRETE HOUSEKEEPING PADS

100 mm thick minimum concrete housekeeping pads for all floor mounted equipment including casings, plenums and equipment installed on vibration isolators.

### 2.03 EQUIPMENT ISOLATORS

- A. Spring:
  - 1) Provide equipment isolator for floor mounted, low pressure packaged HVAC units; individual spring isolators with adjustable leveling bolts and anti-skid pad, arrange around perimeter of equipment to properly support load.
- B. Rubber:
  - 1) Individual double neoprene or rubber isolators with friction surfaces top and bottom; arrange around perimeter of equipment, bolt isolators to equipment with adjustable leveling bolts.

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### 2.04 ISOLATION BASES

- A. Rubber Rail:
  - 1) Rail type, with slotted motor slide base, double neoprene or rubber.
- B. Spring:
  - 1) Rail type fabricated of I-beam sections with slotted motor slide base and spring isolators.
- C. Spring Floating:
  - 1) Isolation base shall consist of frame and spring isolators furnished as an assembly, plus a reinforced concrete inertia base, poured into the frame. Provide for floor mounted fans and pumps over 3 kW and high pressure packaged HVAC units.
- D. Kinetic Floating Floor:
  - 1) Kinetic floating floor shall consist of either roll out or jack up system designed to NC required.

### 2.05 ISOLATION HANGERS

- A. Rubber:
  - 1) Double deflection neoprene or rubber suspension type within a steel housing. Provide for air terminals.
- B. COMBINATION SPRING AND RUBBER
  - 1) Steel compression spring and neoprene or rubber isolator unit within a steel housing.  
Provide for suspended fans and piping within 15 m of connected rotating equipment.

### 2.06 FLEXIBLE DUCT CONNECTORS

- A. Refer to specification section 15910.
- B. Flexible connections shall be a minimum of 150 mm long.

## **PART 3 INSTALLATION**

### 3.01 GENERAL

- A. All equipment, piping and ductwork shall be mounted on or suspended from approved foundations and supports, all as specified, as shown, and as required. All concrete foundations including thickened structural slab, housekeeping pads and concrete for inertia pads shall be provided under this contract.
- B. All supports, hangers and brackets shall be of the seismic type. Calculation of loading along with support and hanger selection, and shop drawing shall be submitted to Engineer for approval.
- C. Provide shop drawing and templates for all concrete foundations. Provide necessary integral steel framing, concrete reinforcing rods welded to frame, required anchor bolts, spring mountings and neoprene pads. The works to be coordinated with other operations carried out in the normal sequence on site.

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- D. The foundations and vibration isolation mountings for the various equipment, piping and ductwork shall be in accordance with the requirements detailed on the Drawings and as specified.
  - E. Where spring vibration isolators are called for, they shall be horizontally stable bare springs unless otherwise indicated. Static deflections shall be minimum 40mm unless otherwise indicated, and selections shall include 50% additional reserve deflection.
  - F. Where a ribbed rubber assembly is called for it shall be factory fabricated from two thicknesses, unless otherwise indicated, of 6mm thick ribbed neoprene pads and shall be square in shape. Pads shall be arranged so that ribs run in opposite directions. Between each pad shall be a 1.6mm thick galvanized steel shim plate integrally and permanently bonded to the neoprene pads and base plate. The unit shall be sized so that the ribbed neoprene pads shall be loaded 150 to 200 kPa.
- 3.02 MOUNTING OF SUSPENDED FANS, AIR HANDLING AND FAN COIL UNITS : (MOUNTING TYPE – 1)
- A. Units shall be hung from resilient hangers.
  - B. These hangers shall be combination rubber-in-shear and spring hangers.
  - C. Each unit not having sufficient frame rigidity shall be provided with an integral steel base for support of the suspended fan unit.
- 3.03 MOUNTING OF PUMPS: (MOUNTING TYPE – 2)
- A. Mount all base mounted pumps directly on a suitably reinforced, steel framed, concrete inertia pad which in turn shall be supported by spring isolators.
  - B. Spring type isolators shall be free standing and laterally stable without any housing and complete with 6 mm neoprene acoustical friction pads between the base plate and the support.
  - C. All mountings shall have leveling bolts that must be rigidly bolted to the equipment.
  - D. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load.
  - E. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.
  - F. Submittals shall include spring diameters, deflections, compressed spring height and solid spring height.
- 3.04 WATER PIPING IN MECHANICAL ROOM AND PUMP ROOM: (MOUNTING TYPE – 3)
- A. Piping shall be hung from resilient hangers.
  - B. These hangers shall be combination rubber-in-shear and spring hangers.
  - C. The spring in each such hanger shall have an initial deflection of 25mm under the installed load.
- 3.05 MOUNTING OF CENTRIFUGAL EXHAUST AND VENTILATION FANS : (MOUNTING TYPE – 4)

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- A. Fans shall be mounted on an integral rigid steel base which shall, in turn, be supported by a suitable number of properly located horizontally stable, large diameter spring vibration mounts.
- B. The springs shall have an initial deflection of 25mm, under the installed load and a minimum additional travel to solid of 12mm.

### **3.06 MOUNTING DX PACKAGE UNITS: (MOUNTING TYPE – 4)**

- A. Units shall be mounted on an integral rigid steel base which shall, in turn, be supported by a suitable number of properly located horizontally stable, large diameter spring vibration mounts. Springs shall be supported by a concrete pad.
- B. The springs shall have an initial deflection of 25mm, under the installed load and a minimum additional travel to solid of 12mm.

### **3.08 FLEXIBLE DUCT CONNECTORS**

- A. Flexible connections to prevent the transmission of vibration through the ducts shall be installed on both the supply and return sides of all fans and ventilation units approximately where shown on the Drawings.

END OF SECTION 15210

**SECTION 15410  
PLUMBING PIPING**

**PART 1 GENERAL**

**1.01 SCOPE OF SECTION**

- A. This technical Specification establishes the minimum requirements for the equipment to be incorporated into the above ground Soil, Waste and rainwater and hot and cold water services plumbing pipework.

It also establishes the quality of materials and workmanship to be used in the supply and installation of the systems.

**1.02 WORK INCLUDED**

- A. Provision of all labour, materials and the performance of all operations necessary for the supply and installation of pipework and fittings of the soil and waste systems as specified herein and as detailed on the Drawings.
- B. Coordination: The Contractor shall ensure that the soil and waste systems are fully compatible with all trades, particularly those of the Civil, Mechanical and Electrical services, for successful installation and operation.
- C. Submittals: The Contractor shall submit to the Engineer for review and approval, all calculations and drawings for the equipment proposed and associated builders works to show that the plant as installed will meet all the specified criteria.

No works shall commence on the site until the design has received the approval of the Engineer.

**1.03 QUALITY ASSURANCE**

- A. Manufacturers: The contractor shall only propose the use of materials produced by firms who have been regularly engaged in the manufacture of plumbing pipework systems and whose products have proved satisfactory in similar service for not less than 10 years.
- B. Installer: Firms proposed for the installation of the plumbing pipework systems shall have been regularly engaged for at least 5 years in the installation of plants of a similar type, quality and scope as is required for this project.

**1.04 APPLICABLE CODES AND STANDARDS**

- A. The plumbing pipework shall comply fully with the latest relevant British and Jordanian Standards in all respects.
- B. The following are the most commonly used and relevant British and Jordanian Standards associated with Soil and Waste Systems. However the Contractor shall ensure that all applicable British and Jordanian Standards are complied with, whether listed here or not.

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- BS: 3380 - Wastes (excluding skeleton sink wastes) and bath overflows. In conjunction with BS 2779, 3643 and 5572.
- BS: 3505 - Specification for uPVC pressure pipes.
- BS: 3943 - Plastic waste traps. In conjunction with BS 2779 and 3380.
- BS: 3974 - Pipe supports.  
(Part 1 & 2)
- BS: 4118 - Glossary of sanitation terms.
- BS: 4514 - Unplasticized PVC soil and ventilating pipes, fittings and accessories.
- BS: 4576 - Unplasticized PVC rain water goods. In conjunction with BS 2494 Part 2, 4514.
- BS: 4660 - Unplasticized PVC underground drain pipe and fittings. In conjunction with BS 2494, 5955 and CP312.
- BS: 5255 - Plastic waste pipe and fittings. In conjunction with BS 21, 2494, 2779 and 4515.
- BS 5911 - Plain and reinforced concrete pipes and fittings.
- BS 843 - Thermal-storage electric water heaters. In conjunction with BS 3456, Sections 2.21, 2.7 and 3.9 and 3999 Part 2.
- BS 1010 - Specification for drains off taps and stop valves for water services.
- BS 2494 - Elastomeric joint rings for pipework and pipelines. In conjunction with BS 1179, 3502, 3574, 4250, and 4947.
- BS 2779 - Pipe threads. for tubes and fittings where pressure-tight joints are not made on the threads
- BS 3284 - Polythene pipe (type 50) for cold water services. In conjunction with BS 21 and 5556.
- BS 3505 - uPVC pressure pipes for cold potable water. In conjunction with BS 21 and CP 312.
- BS 3605 - Seamless and welded austenitic stainless steel pipes and tubes for pressure purposes. In conjunction with BS 3600.
- BS 3955 - Electrical controls for household and similar general purposes
- BS 3974 - Pipe supports.  
Part 1 & 2
- BS 4346 - Joints and fittings for use with uPVC pressure pipes. In conjunction with BS 3505, 3506, 4576, 4660, 5481 and 6209.



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- BS 4368 - Compression coupling for tubes. In conjunction with BS 1706, 2051, 2779, 2871, 3601, 3602, 3605, 3643, 4368 and Din 2353.
- BS 5114 - Performance requirements for joints and compression fittings for use with polyethylene pipes. In conjunction with BS 1972, 1973, 2494 and 3284.
- BS 5433 - Underground stop valves for water services. In conjunction with BS 21,61,864, 1972, 3284, 3885 and 5728 Part 1 and 2.
- BS 6281 - Devices without moving parts for the prevention of contamination of water by backflow. In conjunction with BS 864, 2779, 2872, 4504, 5412 and 5413.
- BS 1387 - Galvanised steel medium and heavy duty.
- BS 6675 - Servicing valves (copper alloy) for water services. In conjunction with BS 864, 1400, 2871, 2872 and 2874.
- BS 6700 - Design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages.
- BS: 5481 - Unplasticized PVC pipes and fittings for gravity sewers. In conjunction with BS 2494, 4660 and CP 312.
- BS: 5572 - Sanitary pipework. In conjunction BS 416, 437, 1188, 1387, 1710, 1973, 2871, 3506, 3868, 4118, 4514, 5254, 5255, CP3.
- BS: 6283 - Safety devices for use in hot water systems. In conjunction with BS 864, 2056, 2779, 2872, 2874, 3075, 3457, 4504, 5412 and 5413.
- BS: 8000 - Part B Section 3 - Above ground drainage
- BS: 6367 - Drainage of roofs and paved areas

In addition to the above standards the works shall be in accordance with all local by-laws, local municipality requirements and the manufacturers recommendations.

### 1.05 SUBMITTALS

- A. Drawings - refer to Section 15010
- B. Products - submit full manufacturers data for every item.

### 1.06 OPERATION AND MAINTENANCE DATA

- A. Comply with Section 15010.

### 1.07 WARRANTY

- A. Provide 12 month warranty in accordance with contract conditions.

## **PART 2 PRODUCTS**

2.01 SOIL WASTE AND RAINWATER PIPEWORK

A. Pipework and fittings

1. All main soil, waste and rainwater stack pipes shall be installed in UPVC.

B. Vent / antisiphon pipework

1. All vent and antisiphon pipework pipes shall be installed in UPVC pipework .
2. The jointing of the pipework and fittings shall be by the use of solvent weld sockets and shall be carried out in full compliance with the manufacturer's recommendations.
3. Expansion joints and pipe support brackets shall be installed in accordance with the manufacturer's recommendations and BSCP312.
4. Sleeves shall be provided where pipes pass through walls or floors to allow free axial movement of the pipes. Sleeves shall be of galvanized steel pipe work, and two pipe sizes larger than the pipe being protected and packed with mineral.
5. Where such pipes pass through fire compartment walls, floors or ceiling cavity barriers the pipes shall be installed with fire sleeves.

C. UPVC branch soil waste and vent pipework

1. The soil, waste and vent pipework shall be UPVC TO BS4514.
2. The soil waste and vent pipework shall have solvent joints in general, with expansion joints where specified.
3. All pipework shall be adequately supported at the centers indicated in Table 13 of BS5572. All PVC pipework shall be supporting with extension expanding ragbolt fixings in the brickwork. Where the brackets are to be used as anchor points they will be made to grip the pipe by means of a rubber sleeve, and must support the pipe with additional studding and back plates to the duct wall. All horizontal waste pipework shall be supported on the manufacturer's screw-to-wall brackets.
4. All waste pipes shall fall from fittings to their respective main soil pipe so as to be self-draining. Branch vent pipes shall rise towards their respective main vent pipe so as to be self-venting.
5. All branch waste pipes to a range of fittings shall have an access provided on the pipe in an accessible position at the end of the run. All traps shall be adequately ventilated in order that the seal may be maintained.
6. Water closets shall be connected by flexible self sealing w.c. "Multikwik" connector, and shall be discharged into adjacent soil pipe.

D. PVC traps

1. All basins shall be provided with an appropriately sized PVC bottle trap to BS3934.

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2. All sinks, etc, and other mechanical and specialist items of equipment, shall be provided with an appropriately sized white PVC "P" or "S" trap to BS3943 (unless such specialist item of equipment is supplied with its own integral trap).
3. Traps to be chrome plated where exposed to view, and in these situations a chrome plated cover plate shall be provided to mask the penetration of the waste pipe through the duct wall or structure. Approval shall be obtained from the local Public Health Authority of all types of traps that are intended for installation. All traps shall have a 75 mm water seal.

### 2.02. POTABLE COLD WATER SERVICES

#### A. PIPEWORK AND FITTINGS

1. Pipes:
  - a. XLPE Pipes with oxygen barrier to DIN standards and matching fitting for Domestic cold water from water manifolds to Sanitary Fixtures. Pipes shall have DVGW or equal approvals for use in domestic applications.
  - b. PP-RCT Pipes to DN 1988 DVGW and DN 8076 ,8077 ,8078 , 2999 , 16928 , OHSAS 18001 ,DVGW 534E Pipes from water tanks to water distribution boxes.

#### B. SYSTEM DESCRIPTION

1. This section relates to the installation of potable cold water systems at all facilities.
2. Incoming pipeline from the water mains shall be provided.
3. Internal Potable Water Installation:
  - i. All cold water supply piping inside the building from water distribution boxes to fixtures shall be made of XLPE unless other wise indicated on relevant drawings. The piping layouts are as indicated on the drawings.
  - ii. Potable water supply is provided for all uses.

#### C. PIPEWORK SUPPORTS

Pipework supports and hangers will comply with Section 15511.

#### D. Thermal insulation shall comply with Section 15450.

### **PART 3 EXECUTION**

#### 3.01 SOIL WASTE AND RAINWATER PIPEWORK

##### A. Workmanship

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1. Materials and workmanship to be of best quality and executed in accordance with the Specification, drawings and manufacturers recommendations.
  2. Where any pipe is required to be shortened it shall be cut off square and cleanly with an approved pipe-cutting machine.
  3. Where special joints or jointing materials are shown for pipes of any materials, they shall be of an approved type and manufacture, and the joint shall be made in accordance with the manufacturer's instructions, or as directed.
  4. Responsibility shall be assumed to identify and install all necessary expansion couplings and fire sleeves throughout the installations.
  5. All plant, pipes and fittings etc shall be thoroughly cleaned of all foreign matter before installation. Each section of the installation shall be clean and free from any obstructions whatsoever before proceeding with the next section of the installation.
  6. All vertical soil, waste and vent pipes are to have access doors provided on each floor, above flood level of fittings served. Access to be provided in ducts to sanitary services. All vent pipes are to terminate 300 mm above roof level, with suitable weathering slate apron and vent cowl or copper wire balloon.
  7. Flexible joints are to be provided wherever pipes cross expansion joints.
  8. All soil, waste, vent and rainwater pipes shall be the size and positions indicated on the drawings to take the discharge from the branch waste and vent pipes, sanitary fittings and equipment adjacent thereto.
  9. On completion the whole of the work is to be handed over in a sound and clean condition. In the event of any pipe being fractured from any cause whatsoever after having been (to all appearances) properly installed, responsibility shall be assumed in every instance and any such defective pipes shall be replaced for approval.
  10. All pipework shall be erected to present a neat and orderly appearance, arranged parallel to or at right-angles to the structural members of the buildings, giving maximum headroom and shall not obstruct windows or doorways. Pipes shall bend round piers, projections and into recesses forming part of the structural works whether so indicated on the drawings or not. Pipework shall be erected such that there is a minimum clearance of 75 mm to finished floor level and a minimum clearance of 25 mm to finished wall faces.
  11. Slopes of drainage system (gravity) shall be a minimum of:
    - Foulwater - 1%
    - Drain and rainwater pipes - 1%
- B. The discharge pipework shall be so installed as to minimize the risk of blockage. Access covers and/or rodding eyes are to be positioned such as to enable maintenance equipment to be inserted into the system(s) to permit cleaning or clearing of all sections of the system(s).

The pipework system and fittings are to be installed so that broken or defective parts can be easily removed and replaced.

The discharge pipework shall ensure that there is no leakage of contaminated water or foul air into any building.

- C. The work shall be set out and responsibility assumed for the accuracy of the same, and the Client's representative shall approve the position of all fittings. When first setting to any work, consideration must be given to the work of other trades.
- D. Responsibility shall be assumed for leaving all unfinished works in safe conditions during the progress of the works.

All materials & equipment are to be installed and protected in such manner as to be adequately covered against damage and deterioration, and during the execution of the work the open ends of all pipework shall be temporarily plugged off by means of blank ends and compression caps respectively.

E. Vent pipe roof termination

- 1. Discharge stacks complete with domicil cages shall terminate not less than 300 mm above the roof, 900 mm above and not less than 3000 mm, measured horizontally from any window or air conditioner.
- 2. Where the stack passes through floors, ceilings and roofs, the openings are to be perfectly sealed-off by proprietary fittings. They shall terminate with neoprene aluminium weathering slate, weathering collar; and a balloon grating on 180° bend.

F. Connection to sanitary fittings

All outlets shall be trapped and provided with accessible and adequate means of removal and cleaning. The traps shall be designed to be self-cleaning all surfaces and joints are to be smooth.

- 1. All traps with outlets for pipes up to and including 50 mm shall have a minimum water seal of 75 mm.
- 2. Traps with outlets for pipes of over 50 mm shall have a minimum water seal of 50 mm.

The waste pipes to the various sanitary fittings shall be of the following sizes:

Wash basins	50 mm diameter
W.C's	110 mm diameter
Shower bath tray	50 mm diameter
Floor gullies	75 mm diameter
Sink	40 mm diameter
unit tubular tray	50 mm diameter

G. Self siphonage tests

The contractor shall undertake tests for self-siphonage and induced siphonage in branch discharge pipes by fitting each appliance to over flowing and then discharging by removing the plugs and discharging the W.C(s) at the upstream end of the discharge pipe. All seals are to remain in the traps.

The numbers of sanitary appliances to be discharged for this performance test are enumerated below:

Type of Use	Number of appliances of each kind on the stack	Number of appliances to be discharged simultaneously		
		9 litres WC	Wash basin	Kitchen sink
Domestic	1 to 9	1	1	1
	24 to 24	1	1	2
Congested	1 to 24	1	1	
	5 to 9	1	2	
	10 to 13	2	2	
	14 to 26	2	3	
	27 to 39	3	4	
	40 to 50	3	5	

#### H. Testing and commissioning

1. All tests requested by Local Municipality or engineer on the entire installation shall be carried out, and all necessary appliance and equipment for this purpose shall be supplied.
2. Provision shall be made to carry out any test requested at any time during the progress of the works or after their completion.
3. Whilst phased testing may be carried out (which may or may not have been witnessed) it will be required to demonstrate the watertightness, alignment, and level and cleanliness of the whole installation seven days prior to the installation.
4. This requirement will be discharged by the applying a full running water test to the whole installation as described below and by the drawing through of a drain profile which will be provided to the required detail.
5. All tests shall be carried out in the presence of the Client's representative, and seven days notice shall be given readiness to test any section of the installation. Test Certificates shall be submitted to the person witnessing the test, for their signature of approval, to the effect that the system satisfies the requirements of this Specification.
6. All sections of works must be pretested to satisfy that the system will pass the required test, prior to carrying out the main test.
7. The Test Certificate shall be required to be completed for all sections of the installation.
8. After erection and immediately prior to sealing in, all rainwater, main soil, waste, vent and branch soil, waste pipes, shall be checked throughout for obstructions and finally tested for soundness.
9. The above ground sanitation and rainwater pipe installation shall be subjected to two air tests, one of 75 mm water gauge for a minimum period of 15

minutes prior to connection of sanitary fittings and building in of pipework, and a second air test on completion of the system with all traps and WC's connected when the test pressure shall be 45 mm water gauge for a minimum period of 15 minutes. Water test according to Jordanian codes may be used as an alternative.

10. At start of testing sanitation and Rainwater Pipework shall be checked for alignment and stability; mechanical joints shall be re-torqued where necessary.
11. Access doors shall be removed, felt washers greased and doors replaced.
12. The whole system shall be rodded through with an appropriately sized disc type plus the allowance shall also be made for testing to the Local Authority requirements and for carrying out separate and independent tests if required.
13. The provision shall also be made for obtaining an acceptance test certificate form the Local Authority on completion of the works. The test for the Local Authority shall be allowed for as an addition to the tests required under this specification.

### 3.02. POTABLE COLD WATER SERVICES PIPEWORK

#### A. Product handling

1. All products shall be delivered in manufacturer's original protective packaging. All products shall be inspected at time of delivery for damage and for compliance with Specifications. Any products that are found to be damaged or not in accordance with the Specifications shall immediately be repaired or removed from the site and replaced. Repairs shall not be undertaken before the Engineer's review of Contractor's proposed action.
2. All products shall be handled and stored as recommended by the manufacturer to prevent damage and deterioration. The Contractor shall supply handling equipment such as lifting beams, reinforced canvas slings, protective padding, struts, cradles, etc., required to handle the products without damaging hardware or linings and coatings.
3. Products shall be protected against damage and the ambient conditions both during transport, site storage and immediately up to the time products are installed. Precautions shall be taken to protect the product from mechanical damage and the effect of sunlight heat, until the backfilling operations have been completed. All site storage areas shall be shaded.

#### B. Installation of pipework

1. Pipework from pump room to the inside of the buildings where running below ground level shall be galvanized steel pipes class (B). Pipes inside shaft to roof tanks and from roof tanks to water distribution boxes shall be galvanized steel pipes class (B). The distribution within Toilets and wet areas shall be XLPE pipes except for laboratory where CPVC pipe work shall be used..

Joints in buried pipework shall be kept to the absolute minimum. Marker tapes shall be laid 150 mm above the pipework. If valves are required, they

are to be in a valve chamber with the surface box lettered to indicated what service is below them.

2. The underground pipework shall be laid in 200 mm of sand or stone free bedding material and wherever possible in straight lines to uniform gradients. The clearance between the pipework and footings of the buildings is not to be less than 200 mm. If less, the pipes shall be installed in a flexible sleeve.
3. All pipework shall run vertically or at an inclination of 1° to the horizontal to enable the whole system to be drained off either through the system or through a valve discharging externally with an air gap to prevent contamination by backflow. When the pipework is drained down, air is to be allowed into the system to prevent failure or damage to the hot water cylinder. A manual air inlet valve shall be fitted to the high point in the system to achieve this.
4. Where pipes are run in walls, floors, etc., all pipework shall be insulated.
5. All pipework shall be erected to present a neat and orderly appearance, arranged parallel to or at right-angles to the structural members of the buildings, giving maximum headroom and shall not obstruct windows or doorways. Pipes shall bend round piers, projections and into recesses forming part of the structural works whether so indicated on the drawings or not. Pipework shall be erected such that there is a minimum clearance of 75 mm to the finished floor level and at least 25 mm to the finished wall faces.
6. All fittings shall, as far as practicable, be the same size as the tubes and pipes connected to them. Bushed outlets will only be accepted if the required outlet size of a fitting is not of standard manufacturer. Eccentric bushings and square tees shall be used where concentric bushing and pitcher tees might cause air to be trapped in the system. Elsewhere square tees shall be confined to dead-leg branches of domestic hot water supply systems and on cold-water branches to fitting or ranges of fittings.
7. Elbows shall be used, where practicable, in preference to bends Square elbows will not be permitted.
8. Pipework shall follow the contours of walls and shall be graded to ensure venting and draining. The clearance between pipework (or the insulation) and the wall and any other fixtures shall be not less than 20 mm.
9. Purpose-made sets or springs may be used where it is necessary to deviate from a straight run.
10. Sets or springs in tubes of 50 mm size and above shall be fire-made and tubes shall remain circular after setting.
11. Eccentric reducing sockets shall be used where changes of bore are made in runs of nominally horizontal pipework to facilitate air venting and draining.
12. Tubes shall be reamed after cutting and shall be free from burrs, rust scale and other defects and shall be thoroughly cleaned before erection. Open ends left during the progress of work shall be temporally closed with purpose-made metal or plastic plugs or caps, or blank metal flanges.



13. Where pipe passes through walls, ceilings, shall be provided. Pipe passing through flooring shall be provided with approved type floor and ceiling plates fastened securely to the pipe. The sleeves to be of the same metal as the pipe.
14. All entry and exit holes to or from a building for pipework services shall be sealed and plugged. For service conditions below 60°C the sealant shall be mastic compound, above this temperature it shall be silicon rubber. Where the pipework enters the building through a large hole or duct, a mild steel blanking plate not less than 6 mm thick shall be built into the walls of the hole or duct. The service pipes shall pass through clearance sockets welded to the plate and the space between pipe exterior and socket interior shall be sealed and plugged.
15. All pipes shall be secured by copper or copper alloy clips or brackets to allow for thermal movement and support at spacings not exceeding 300 mm for copper pipes up to 38 mm diameter and 400 mm for those up to 75 mm diameter.
16. Pipework of 75 mm size and larger subject to expansion and contraction and hung from supports shall be suspended on swivel hangers unless otherwise agreed.
17. Hangers for horizontal pipework shall be supported in accordance with the requirements of Section 15412 support, Hangers and Brackets.
18. Piping that is insulated shall be secured by clips that allow sufficient space behind the back of the pipe for the pipe insulation to be properly installed.
19. All pipework shall be installed so that the vertical distance between the discharge point and overflow level of the receiving appliance shall not be less than 25 mm for taps and/or fittings up to and including 20 mm and 70 mm for those over 20 mm to prevent contamination as result of backflow of water.
20. A 15 mm diameter washout pipe, discharging outside the building will be provided at ground floor level to drain the system. The top of the outlet is to be in excess of 70 mm from the ground or receiver.

B. Storage

1. All pipework shall be stored on purpose made pipe racks of welded construction and of sufficient strength to support the entire weight of the materials without any noticeable deformation. The racks shall be such that all pipework is clear of the ground.
2. Pipework fittings shall be stored within a well-lit container made compartmented racks or shelves. The fittings shall be separated by means of their type and size and laid out in an orderly manner for ease of identification.

C. System testing

1. The Contractor shall ensure that all pipework is watertight to the satisfaction of the Engineer and shall supply all pressure gauges, meters, hoses, pumps and other temporary supports, equipment and manpower necessary for carrying out pressure tests.

2. The Contractor shall, during testing, check the satisfactory operation of each valve installed under the Contract.
3. Before filling or pressure testing is started the Contractor shall re-check pipes and valves for cleanliness and shall re-check the operation of valves. The open ends of the pipes shall normally be stopped off by blank flanges or capped ends additionally secured where necessary by temporary struts and wedges.
4. Potable water system shall be tested with water to 1.5 times the normal system working pressure or 6 bar whichever is greater while uncovered but adequately anchored. The testing shall be carried out in sections if necessary. If a section should fail the test, the Contractor shall trace and repair all leaks and defects and retest the section before any further pipes or section of adjacent pipework are laid.
5. The system shall be filled with potable water and all air expelled. After the system has been completely filled, the pressure shall be steadily and gradually increased until the test pressure has been reached. If any loss is recorded, repairs shall be made and the test re-run.
6. Written records of every test clearly identifying the tested system together with time of test and name of testing Engineer in tabulated format shall be submitted for review by the Engineer upon completion of the test.

D. Flushing and disinfection

1. Potable water pipelines shall be flushed with potable water after completion of pressure testing and before introducing disinfection.
2. Liquid chlorine, calcium hypochlorite shall be used for disinfection. Where chlorine is used, it shall be introduced only in conjunction with proper equipment and under the supervision of qualified personnel familiar with the physiological, chemical and physical properties of liquid chlorine and who are suitably trained and equipped for dealing with any emergency which may arise from its use.
3. Potable water from a suitable source shall be injected with flow control at a constant and measured rate. The water shall receive a dosage of chlorine fed at a measured rate to ensure chlorine concentration in the water entering the pipe is maintained at a minimum of 50 mg/l. The chlorine residual shall be measured at regular intervals to ensure that the required chlorine concentration is maintained.
4. During the application of chlorine, valves shall be manipulated to prevent the treatment dosage from flowing back into the line supplying the water. Chlorine application shall continue until the entire pipeline is filled with chlorine solution.
5. After 24 hours retention, the chlorinated water shall be flushed out with potable water, until the chlorine concentration in the water leaving the pipeline does not exceed 21 mg/l. Chlorine residual determination shall be

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made to ascertain that the heavily chlorinated water has been removed from the pipeline.

6. Flushing water shall be discharged only to sites or into conduits. Discharges, which cause damage, create nuisance or health hazard, or interfere with the work of others will not be permitted.

END OF SECTION 15410

## SECTION 15411

### PLUMBING VALVES

#### PART 1 GENERAL

##### 1.01 SCOPE OF SECTION

- A. This technical specification establishes the type and quality of materials, and the standard of workmanship to be used in the supply and installation of valves.

##### 1.02 WORK INCLUDED

- A. The work includes the provision of all labour, materials and the performance of all operations in connection with the supply and installation of valves as specified herein and where referred to on the Drawings.
- B. Coordination: The contractor shall be responsible for the full coordination of the work of all trades.

##### 1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of valves whose products have been in satisfactory use in similar applications for not less than 10 years.
- B. Installer: Firms regularly engaged and qualified in the installation of valves with at least 5 years successful installation experience on projects of a similar nature.

##### 1.04 APPLICABLE CODES AND STANDARDS

- A. The valves and all associated materials shall comply fully with the latest relevant British Standards in all respects.

The following are the most commonly used and relevant British Standards associated with valves and associated materials. However, the Contractor shall ensure that all applicable British Standards are complied with, whether listed here or not.

BS: 21-	-	Specification for Pipe Threads for Tubes and Fittings where Pressure Tight Joints are made on the Threads.
BS: 4504	-	Specification for Ferrous Flanges and Bolting for Pipes, (Part 1) Valves and Fittings.
BS: 4504 (Part 2)	-	Specification for Copper Alloy and Composite Flanges.
BS: 5150	-	Cast Iron Wedge and Double Disk Gate Valves.
BS: 5151	-	Cast Iron Gate (Parallel Slide ) Valves.
BS: 5152	-	Cast Iron Globe and Globe Stop and Check Valves.

- BS: 5153 - Cast Iron Check Valves.
- BS: 5154 - Copper Alloy Globe, Globe Stop and Check, Check and Gate Valves.
- BS: 5156 - Diaphragm Valves.
- BS: 6683 - Guide to Install and Use of Valve.

1.05 SUB

- A. Draw- refer to Section 15010
- B. Products - submit full manufacturers data for every item.

1.06 OPERATION AND MAINTENANCE DATA

- A. Comply with Section 15010.

1.07 WARRANTY

- A. Provide 12 month warranty in accordance with contract conditions.

**PART 2 PRODUCTS**

2.01 GENERAL

- A. Bodies of valves and cocks on mild steel pipework up to and including 50mm size shall be of cast gunmetal or bronze. Approved valves having hot-pressed bodies may be offered as an alternative. Bodies of valves 65mm size and larger shall be of cast iron. Castings and pressings shall be of good quality, clean and smooth and free from scale or flaws.
- B. Holes in covers or in gates for screwed portions of spindles shall have full threads of a length not less than the diameter of the spindle over the thread. Glands shall be machined to provide a running fit between the spindle and the stuffing box. Stuffing boxes shall be properly packed or fitted with "O" rings, which may be located in plastic bushes.
- C. Valves and cocks on mild steel pipework up to and including 50mm size shall have taper screwed ends, and of 65mm size and above shall have flanged ends to BS 4504 Tables 6/2 or 6/5 for welded type and Table 6/4 for screwed type.
- D. All screwed valves shall have heavy hexagonal reinforcements at openings, threads of ample length to ensure sound joint and heavy shoulders to prevent over entry of pipes, fittings or adapters.
  - a. Flanged valves shall have flat-faced flanges conforming to BS 4504.
- E. All valves and valve components (e.g. seatings, packings, etc.) shall be suitable for the working pressures, operating temperatures and conditions of the fluid handled in the systems in which they will be installed. All valves shall be hydraulically tested to at

least twice the working pressure of the systems in which they will be installed. Where necessary valves shall have extended spindles to facilitate insulation. The declared pressure rating of the valve shall be equal to or greater than the maximum test pressure of the system.

- F. The working pressure for valves is to be based on the total static pressure in the pipework in addition to the operating pressure exerted by the pumps on the system.
- G. Each valve shall have the manufacturer's name or trade mark, the BS number, the nominal diameters, the nominal pressure rating and body material all identified in the form of stamped or cast body markings.

## 2.02 ISOLATING VALVES

- A. Isolating valves up to and including 50mm nominal bore shall be bronze or gunmetal gate valves to BS 5154 with solid wedge discs, non-rising stems, screwed in bonnets, metal hand wheels and screwed ends to BS 21 (ISOR/7).
- B. Isolating valves for 65mm nominal bore and above shall be cast iron gate valves to BS 5150 with solid wedge discs with bronze trim and seatings, bolted on cast iron bonnets, high grade graphited asbestos packings, rising stems with outside screws and yokes, cast iron handwheels and flanged ends to BS 4504.
- C. Where shown on the drawings or specified herein, lock shield valves shall have easy-clean shields or enclosures to match the inlet valves. As a minimum requirement, one loose key shall be provided for every 25 N<sup>o</sup> valves of the same spindle size.

## 2.03 NON-RETURN VALVES

- A. Non-return valves up to and including 50mm nominal bore shall be of the bronze swing pattern with screwed ends and conforming to the requirements of BS 1400.
- B. Non-return valves 65mm nominal bore and above shall be of the cast iron swing pattern with bolted access covers, solid discs with bronze trim and seatings all to BS 5153 and flanged ends to BS 4504. An air cock shall be fitted to the bolted cover for air release purposes.

## 2.04 DRAIN VALVES

- A. Drain valves shall be of the bronze straight type glanded pattern complete with brass hose union and malleable iron lever conforming to the requirements of BS 1400.

## 2.05 PRESSURE RATINGS

- A. Unless otherwise indicated, use valves suitable for 862 kPa and 232 degrees C. and 1379 kPa minimum and 121 degrees C.

# **PART 3 EXECUTION**

## 3.01 STORAGE

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- A. All valves shall be stored within a well lit container on purpose made compartmented racks or shelves, constructed in a similar manner to support the entire weight of materials without noticeable deformation.
- B. The valves shall be separated by means of their type and size and laid out in an orderly manner for ease of identification.
- C. Valves shall be supplied and stored with purpose made or manufactured plugs to prevent ingress of dirt.

### 3.02 GENERAL INSTALLATION

- A. Valves with screwed ends shall have a union installed adjacent to the valve for ease of dismantling.
- B. Where possible, valves shall be installed with the stem in the vertically upright position. However, all valves shall be installed in a manner such that they are readily accessible for ease of operation.
- C. Sufficient clearance shall be allowed for the application of thermal insulation, valve boxes, etc. and to ensure that full travel of the valve stem can be achieved.

### 3.03 ISOLATING VALVES

- A. Separate isolating valves shall be provided at all pipe work service of each plant equipment and on pipe main and submain, except where flow measuring or regulating valves are required and these valves can be used for isolating purposes without affecting their measuring or regulating functions.

### 3.04 DRAIN VALVES

- A. Drain valves shall be installed at all system low points on the dead side of isolating valves and on all items of plant to facilitate emptying down and removal.
- B. Line sized drain valves shall be installed at the end of each pipework run and at the base of each pipework riser to enable the system to be adequately flushed.

### 3.05 AIR VENTING DEVICES

- A. Air venting devices shall be installed at all system high points.
- B. Automatic air eliminators shall be complete with galvanised mild steel relief pipework, taken to within 1.5 m of the floor level with a gunmetal isolating valve and extended to a position where any discharge will not damage building fabrics, decorations or the like.

END OF SECTION 15411

## SECTION 15412

### PLUMBING SUPPORTS, HANGERS AND BRACKETS

#### PART 1 GENERAL

##### 1.01 SCOPE OF SECTION

- A. This technical Specification establishes the type and quality of materials and the standard of workmanship to be used in the supply and installation of Supports, Hangers and Brackets.

##### 1.02 WORK INCLUDED

- A. The work includes the provision of all labour, materials and the performance of all operations in connection with the supply and installation of Supports, Hangers and Brackets as specified herein and where referred to on the Drawings.
- B. Coordination: The Contractor shall be responsible for the full coordination of the work of all trades.

##### 1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of Supports, Hangers and Brackets whose products have been in satisfactory use for a similar application for not less than 10 years.
- B. Installer: Firms regularly engaged and qualified in the installation of pipework systems with at least 5 years successful installation experience on projects of a similar nature.

##### 1.04 APPLICABLE CODES AND STANDARDS

- A. The Supports, Hangers and Brackets and all associated materials and workmanship shall comply with the latest relevant British Standards in all respects.

The following are the most commonly used and relevant British Standards and Saudi Arabian Standards associated with pipework products and associated materials. However, the Contractor shall ensure that all applicable British Standards are complied with whether listed here or not.

BS 5572	:	Sanitary pipework.
BS 1387	:	Specification for screwed and socketed steel tubes and tubulars and for plain end steel tubes suitable for welding or for screwing to BS 21 Pipe Threads. 8mm - 150 mm dia.
BS 3505	:	uPVC pressure pipes for cold potable water. In conjunction with BS 21 and CP 312.
BS 3974 (Part 1 & 2)	:	Pipe supports.
ASTM F 437	:	Threaded CPVC Plastic Pipe Fittings Schedule 80



ASTM F 439 : Socket type CPVC Plastic Pipe Fittings Schedule 80

ASTM D 1784: Rigid PVC Compounds and CPVC Compounds.

1.05 SUBMITTALS

- A. Drawings: Refer to Section 15010.
- B. Products: Submit full manufacturers data for every item.

1.06 OPERATION AND MAINTENANCE DATA

- A. Comply with Section 15010.

1.07 WARRANTY

- A. Provide 12 months warranty in accordance with the contract conditions.

1.08 EXTRA MATERIALS

- A. Comply with Section 15010.

**PART 2 PRODUCT**

2.01 GENERAL

- A. All supports, hangers and brackets shall be of an approved manufacture as herein and indicated on the drawings.
- B. All steel products used for support systems if not manufactured from malleable cast iron or stainless steel shall be either galvanised or painted with one coat of red oxide paint.
- C. All drop rods shall be galvanised and sized to suit the bracket type and system weight but in no case shall be less than 6 mm diameter.
- D. All materials used for support systems shall be compatible with the material they are supporting. Generally steel pipework shall be supported by cast iron and steel clips, copper pipework by copper or brass clips and UPVC pipework by brass or PVC clips. Where galvanised steel pipework is used all pipework clips shall be galvanised.
- E. Where brackets are exposed to view they shall be of a chrome plated finish.
- F. Fixings to concrete and masonry shall be of the expanding bolt or wedge anchor type selected in accordance with the manufacturers recommendations and suitable for the imposed loads. Where fixings are to be made close to the outside edge of concrete or masonry structures resin banded fixings shall be used to reduce the risk of fracture.
- G. Brackets for fixing to woodwork or lightweight partitioned walls shall be of the screw on pattern.

- H. Purpose made girder clamps shall be used where any system is supported from steelwork and only with the approval of the Engineer.

### PART 3 EXECUTION

#### 3.01 STORAGE

- A. All continuous lengths of channel angle and screwed rod shall be stored on purpose made pipe racks of welded construction and of sufficient strength to support the entire weight of the material without any noticeable deformation. The racks shall be such that all material is clear of the ground.
- B. All raw metal shall be wire brushed and painted with one coat of red oxide paint prior to storage.
- C. All general support materials shall be stored within a well lit container on purpose made compartmented racks or shelving. The materials shall be separated by means of their type and size and laid out in an orderly manner for ease of identification.

#### 3.02 GENERAL

- A. All systems shall be adequately supported in such a manner as to permit free movement due to expansion, contraction, vibration or other changes in the system. Supports shall be arranged as near as possible to joints and changes in direction.
- B. Vertical rising pipes and ducts particularly in shafts shall be adequately supported at the base to withstand the total weight of the riser. Under no circumstances shall branches from vertical rising pipes be the means of support for the vertical pipework.
- C. Hangers for horizontal systems at high level shall be supported from angle or channel irons suitable for securing to the structure.
- D. Pipework shall be independently supported; double stacking of pipes from the same support will not be permitted.
- E. Adjustable mild steel hangers on steel pipework systems shall be used with swivel joints at the pipe rings and spherical washers at the top of the hanger rods. Pipe rings shall be malleable cast iron or fabricated steel made in halves and secured by bolts or screws. Malleable iron hinged pipe rings may also be used but caliper hooks shall not be permitted. Pipework 65 mm diameter and over shall not be supported using malleable iron brackets. All pipe brackets over 50 mm diameter shall be submitted to the Engineer and approved by the Engineer prior to manufacture.  
Where rollers and chairs are required, these shall be preformed and where used singularly they shall have restraining "U" straps or bolts formed over the diameter of the pipe and bolted to the base support of the chair. The "U" straps or bolts shall be fitted to allow movement of the pipe without binding. Continuously threaded "U" bolts will not be permitted.
- G. The spacing of supports shall be determined in accordance with the following table. Where one support carries more than one pipe of different diameters the spacing shall be determined by the requirement of the smallest diameter.

Maximum spacing of fixings for internal piping

Type of piping	Nominal size of pipe (mm)	Spacing on horizontal run (m)	Spacing on vertical run(m)
Steel complying with BS 1387	15	1.800	2.400
	20	2.400	3.000

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	25	2.400	3.000
	32	2.700	3.600
	40	3.000	3.600
	50	3.000	4.500
	65	3.000	4.500
	80	3.000	4.500
	100	3.900	4.500
	150	4.500	5.400
Copper complying with BS 2871	15	1.800	2.400
	20	2.400	3.000
	25	2.400	3.000
	32	2.700	3.600
	40	3.000	3.600
	50	3.000	4.500
	65	3.600	4.500
	80	3.600	4.500
	100	3.900	4.500
	150	4.500	5.400
Unplasticized PVC complying with BS 3505	12	0.530	1.060
	15	0.610	1.220
	20	0.685	1.370
	25	0.760	1.52
	32	0.840	1.680
	40	0.910	1.830
	50	1.07	2.13
	75	1.37	2.74
	110	1.52	3.05
	160	1.83	3.66
Chlorinated PVC	20	0.8	1.6
	25	0.8	1.8
	32	1.0	2.0

Figures are for normal ambient temperatures below 20°C. For temperatures above 20°C the pipe manufacturer should be consulted. Based on average temperature of 80°C.

END OF SECTION 15412

## SECTION 15430

### PLUMBING SPECIALTIES

#### PART 1 GENERAL

##### 1.01 SCOPE OF SECTION

- A. This technical specification establishes the type and quality of materials, and the standard of workmanship to be used in the supply and installation of piping specialties.

##### 1.02 WORK INCLUDED

- A. The work includes the provision of all labor, materials and the performance of all operations in connection with the supply and installation of piping specialties as specified herein and where referred to on the Drawings.
- B. Coordination: The Contractor shall be responsible for the full coordination of the work of all trades.

##### 1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacturer of piping specialties whose products have been in satisfactory use for a similar application for not less than 10 years.
- B. Installer: Firms regularly engaged and qualified in the installation of piping specialties with at least 5 years successful installation experience on projects of a similar nature.

##### 1.04 APPLICABLE CODES AND STANDARDS

- A. The piping specialties and all associated materials shall comply fully with the latest relevant British Standards in all respects.
- B. The following are the most commonly used and relevant British Standards associated with piping specialties and associated materials. However the Contractor shall ensure that all applicable British, International, and local standards and regulations are complied with whether listed here or not.

BS EN 10226-1: Pipe threads where pressure tight joints are made on the threads Taper external threads and parallel internal threads. Dimensions, tolerances and designation

BS EN 1092-2: Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Steel flanges

BS EN 1092-2: Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Cast iron flanges

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BS EN 1092-3 :	Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Copper alloy flanges.
BS EN 1917:	Concrete manholes and inspection chambers, unreinforced, steel fibre and reinforced
ASME A112.14.3:	Grease Interceptors

### 1.05 SUBMITTALS

- A. Drawings - refer to Section 15010

Products - submit full manufacturer's data for every item.

### 1.06 OPERATION AND MAINTENANCE DATA

- A. Comply with Section 15010.

### 1.07 WARRANTY

- A. Provide 12 month warranty in accordance with contract conditions.

## **PART 2 PRODUCTS**

### 2.01 PIPE SLEEVES

- A. Pipework sleeves shall be of the same materials as the pipework.
- B. The inside diameter of sleeves shall be such as to allow an 8 mm minimum gap between the finished surface of an insulated pipe and the internal surface of the sleeve. The length of the sleeve shall be limited to prevent the sleeve protruding beyond the finished building surface. Mastic of an approved type shall be inserted between pipe and sleeve as necessary.

### 2.02 FLOOR, CEILING AND WALL COVER PLATES

- A. Floor, ceiling and wall plates shall be plastic and selected to suit the pipework size and material with which they are to be used.

### 2.03 PIPE CLEANOUTS

Shall be the same size as the pipe except that cleanout plugs larger than 4 inches (100 mm) will not be reduced. Cleanouts in connection with other pipe, where indicated, shall be T-pattern, 90-degree branch drainage fittings with cast-brass screw plugs of the same size as the pipe up to and including 4 inches (100 mm). Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks, at the foot of interior downspouts, on each connection to building storm drain where interior downspouts are indicated, and on each building drain outside the building. Cleanout tee branches may be omitted on stacks in single story buildings with slab-on-grade

construction or where less than 18 inches (45 cm) of crawl space is provided under the floor. Cleanouts on pipe concealed in partitions shall be provided with chromium-plated bronze, nickel bronze, nickel brass or stainless steel flush type access cover plates. Round access covers shall be provided and secured to plugs with securing screw. Square access covers may be provided with matching frames, anchoring lugs, and cover screws. Cleanouts in finished walls shall have access covers and frames installed flush with the finished wall. Cleanouts installed in finished floors subject to foot traffic shall be provided with a chrome-plated cast brass, nickel brass, or nickel bronze cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws shall not project above the cover surface. Where cleanouts are provided with adjustable heads, the heads shall be cast iron.

#### 2.04 FLASHINGS

A sheet-lead flashing shield shall be provided for drains and pipe sleeves with integral clamping devices that penetrate a membrane. Flashing shield shall be made from sheet lead not lighter than 4 pounds (20 kg/m<sup>2</sup>), and extend not less than 8 inches (20 cm) from the drain or sleeve in all direction. Flashing shall be inserted into the clamping device and made watertight. Lean flashing shields, and roof flanges of lead or copper flashing with integral flange, shall be set over membrane in a solid coat of a bituminous cement and strip-flashed as specified by the manufacturer. Pipes passing through pitches roofs shall be flashed using lead or copper flashing with an adjustable integral flange of adequate size to extend not less than 8 inches (20 cm) from the pipe in all directions and lapped into the roofing to provide a watertight seal.

#### 2.05 FLOOR AND SHOWER DRAINS

Shall generally consist of body, integral seepage pan and adjustable perforated or slotted strainer consisting of grate and threaded collar. Drains shall be of double drainage pattern suitable for embedding in the floor construction. The seepage pan shall have weep holes or channels which will provide drainage from the pan to the drainpipe. The strainer shall be adjustable to varying floor thickness. A suitable clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing of waterproofing membrane shall be provided when required. In lieu of a caulked joint between the drain outlet and waste pipe, a neoprene rubber gasket may be installed provided that the drain is specifically designed for the rubber-gasket mechanical joint. Certified independent laboratory tests indicating that the rubber gasket compression joint will not leak when tested with not less than 5 feet (1.5 meters) head of water for not less than one hour shall be provided. The rubber gasket joint shall be installed as recommended by the drain manufacturer. Drains shall be provided with separate cast iron "P" traps unless otherwise indicated. Drains shall have circular body, seepage pan, and strainer, unless otherwise indicated.

Floor drain shall be fitted with trap primer were use is intermittent.

#### 2.06 ROOF AND BALCONY, PLANTER DRAINS

Roof, Balcony and Planter drains shall be suitable for the type of roof or planter finish they are to be installed into. They shall have steel body and shall conform to BS EN 1253 or an approved equivalent.

2.07 WATER DISTRIBUTION COLLECTORS “MANIFOLDS”

Water distribution box shall consist of hot and cold water manifolds, isolating ball valves and air vent.

a. Manifolds shall be manufactured of brass or copper and be supplied by the piping manufacturer as a proven cataloged part of the manufacturer's system.

b. Brass manifolds shall be produced from extruded brass round pipe with tapped holes for connections, and be pre-assembled by the manufacturer. 100% of manifolds used shall have been air tested by the manufacturer with no indication of leaks.

2.08 MANHOLES

Shall be constructed in accordance with BS EN 1917 from reinforced cast in situ concrete with benched bottom. The manhole cover and frame shall be double sealed standard weight, and heavy duty in vehicular traffic areas. Steps shall be of cast iron, or galvanized steel or specialist non ferrous material. The manhole shall be internally coated with epoxy, and externally with water proofing membrane. Unless otherwise indicated on the Drawings, manholes and frame sizes shall be as follows:

<b>Manhole Depth (mm)</b>	<b>Manhole Size (mm)</b>	<b>Manhole Cover opening size (mm)</b>
Up to 1.5 m	600 mm dia.	600 mm dia
1.0m to 1.50 m	900 mm dia.	600 mm dia.
More than 1.50m	1200 mm dia.	900 mm dia.

2.09 TRENCH GRATING

Heavy duty grating with angle frame and anchor tabs. shall conform to ASME A112.6.3.

2.10 MOTORIZED CONTROL VALVES

- A. Motorized control valves shall consist of a globe valve, controller, solenoid actuator.
- B. Valve shall be suitable for direct burial. Valve body shall be ductile iron and epoxy coated and flanges shall be class 150. Valve stem and spring shall be stainless steel.
- C. Solenoids shall have stainless steel bodies and watertight explosion proof enclosures

2.11 SUCTION STRAINERS

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a. For Copper and UPVC Pipes: Fabricate from line size copper pipes (Type K Hard) and bronze flange. Minimum total area of perforations (6mm size) shall be four (4) times the sectional area of the pipe. Use straightened pipe fabric brazed to the pipe end as end cap for copper strainers.

b. All fasteners shall be of corrosion resistant material like stainless steel or high tensile brass.

### 2.12 IN LINE Y-TYPE STRAINERS

c. 50 mm (2 inch) nom. dia. and smaller:

- 1) Bronze body with threaded ends, screwed on retainer cap with threaded plug and twenty (20) mesh stainless steel screen. Provide blow off connection with valve on the retainer cap, where required.

d. 65 mm (2 1/2 inch) and larger:

- 2) Cast steel body with flanged ends, flanged cover with threaded bronze plug and stainless steel screen. Provide blow off connection with valve, where required.
- 3) Screen shall have 1.5 mm perforations for sizes from 65 to 100 mm (2 1/2 to 4 inch) nom. dia.
- 4) Screen shall have 3.0 mm perforations for sizes over 100 mm (4 inch) nom. dia.

### 2.13 ACK FLOW PREVENTERS

a. 50 mm (2 inch) nom. dia. and smaller:

Bronze body, stainless steel trim with atmospheric vent, complete with strainer, gate valves, test cocks and air gap fitting at vent connection.

b. 65 mm (2 1/2 inch) and larger:

Bronze body, stainless steel trim with atmospheric vent, complete with flanged strainer and gate valves, test cocks and air gap fitting at vent connection.

### 2.14 AUTOMATIC RELIEF VALVES

#### a. PRESSURE RELIEF VALVES

Bronze body, stainless steel spring and trim, with pipet type manual actuation lever. The unit shall be preset and sealed at the factory. The label shall contain the manufacturer's name, serial no., maximum working pressure and set pressure.

#### b. PRESSURE AND TEMPERATURE RELIEF VALVES:

Bronze body, stainless steel spring and trim, one ceramic coated temperature sensing element and pipet type manual actuation lever. The unit shall be rated for relieving the maximum heat input to the water heater and preset and sealed at the factory. The label shall contain the manufacturers name, serial no., maximum working pressure and temperature, set pressure and temperature and relieving capacity in Btuh.

END OF SECTION 15430



## SECTION 15440

### PLUMBING FIXTURES

#### PART 1 GENERAL

##### 1.01 SCOPE OF SECTION

- A. This technical specification establishes the quality of materials and workmanship to be used in the supply and installation of plumbing fixtures.

##### 1.02 WORK INCLUDED

- A. Provision of all labour, materials and the performance of all operations in connection with the supply and installation of plumbing fixtures as specified herein and shown on the drawings.
- B. Coordination: The Contractor shall be responsible for proper coordination of the work of all trades.
- C. Note for actual specification of type of appliances in toilet areas refer to Section 10800 toilet and bath accessories.

##### 1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of plumbing equipment and fittings whose products have been in satisfactory use in similar service for not less than 10 years.
- B. Installer: Firms regularly engaged in the installation of plumbing works of a similar quality and scope as this project for at least 5 years.

##### 1.04 APPLICABLE CODES AND STANDARDS

- A. The plumbing fixtures shall comply fully with the latest relevant British Standards in all respects.
- B. The following are the most commonly used British Standards associated with plumbing fixtures. However the contractor shall ensure that all applicable British Standards are complied with, whether listed here or not.

BS 1010 part 2	Draw-off taps and stop valves for water services. In conjunction with BS 21, 61, 864, 1224, 1806, 2779, 2879, 3457, 3885 and 4518
BS 1125	W.C. flushing cisterns In conjunction with BS 1212, 2456, 3402, 4781, 5503, 5504 and 6700
BS 1188	Ceramic wash basins pedestals
BS 1189	Baths made from porcelain enamelled cast iron
BS 1206	Fireclay sinks
BS 1224	Electroplated chromium coatings
BS 1254	W.C. seats (plastics)

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- |                     |   |
|---------------------|---|
|                     | In conjunction with BS 771 and 1322   |
| BS 1329             | Metal hand rinse basins<br>In conjunction with BS 1010, 1344, 3380, 3831 and 6731   |
| BS 3380             | Water (excluding skeleton sink wastes) and bath<br>Overflows In conjunction with BS 864, 2779, 3643 and 5572  |
| BS 3402             | Quality of vitreous China sanitary appliances   |
| BS 3456 Section 2.9 | Household and similar electrical appliances<br>2.21, 2.22, 2.34,<br>2.35, 3.6, 3.8, 3.9,<br>102.5, 102.7, 102.11,<br>102.24, 102.31                                 |
| BS 3457             | Water tap and stop valve seat washers   |
| BS 5388             | Spray taps<br>In conjunction with BS 1010, 5412 and 5413  |
| BS 5412             | Draw-off taps with metal and plastic bodies<br>In conjunction with BS 864, 2779, 2871 and 3506  |
| BS 5503             | W.C. pans with horizontal outlets   |
| BS 5504 parts 2 & 3 | Wall hung W.C. pan  |
| BS 5505             | Bidets<br>In conjunction with BS 3402 and 5505  |
| BS 5506 pts.1,2 & 3 | Wash basins   |
| BS 5572             | Sanitary pipework   |
| BS 5627             | Plastic connection for use with horizontal vitreous<br>China W.C. pans<br>In conjunction with BS 65, 416, 437, 1387, 2598, 2871, 3868,<br>4514, 4660, 5503 and 5504 |
| BS 5779             | Spray mixing taps<br>In conjunction with BS 1010, 1415, 5412, 5413 and CP 342   |
- 1.05 SUBMITTALS
- A. Drawings - refer to Section 15010
  - B. Products - submit full manufacturer data for every item.
- 1.06 OPERATION MAINTENANCE DATA
- A. Comply with Section 15010.
- 1.07 WARRANTY
- A. Provide 12 month warranty in accordance with contract conditions.

## **PART 2 PRODUCTS**

### **2.01 GENERAL**

- A. All units and assemblies of sanitary ware shall be as shown on drawings and listed in schedules.

### **2.02 FITTINGS**

- A. Each plumbing fixture shall be installed complete with all necessary fittings for operational and maintenance requirements. All fit exposed to view (i.e. not concealed in chase, void, duct or buried in building structure) shall be heavily chrome plated unless otherwise indicated in the specification or on the drawings.
- B. Each water connection to each plumbing fixture shall have a stop valve. The stop valves shall be the same size as the connection and shall be of the wall fixing angle pattern, complete with a chromium plated copper pipe tail for connection to the fixture.

The fittings to be supplied for each of the plumbing fixtures shall be as follows:

#### Water Closets

- a) Stop valve to cold water supply for cistern .
- b) Hand spray with hose.

#### Wash Hand Basins

- a) Stop valves to cold and hot water supply.
- b) Chrome plated mixer with pop up waste and all accessories.

#### Sinks

- a) Stop Valves to cold and hot water supply.
- b) Chrome plated mixer with pop up waste and all accessories..

## **PART 3 EXECUTION**

### **3.01 STORAGE**

- A. All plumbing fixtures shall be stored in their original containers in a secure enclosed store. Vitreous China ware shall be stored out of direct sunlight. Fittings (Taps, Showers etc.) shall stored in boxes or wrappings to prevent the ingress of dust to machined surfaces. All storage areas shall have adequate artificial lighting to allow for inspection of the equipment by the engineer.

### **3.02 FIXINGS**

- A. All fixings (Screens, Bolts etc.) shall be as supplied and/or recommended by the fitting/fixture manufacturer. The fixings shall be entirely suitable for the medium they are fixing into and shall be chosen to prevent any electrolytic action between any of the installation elements. All fixings exposed to view shall be stainless steel or where only the heads are exposed shall have caps of the same colours as the item they are fixing.

### **3.03 INSTALLATION OF FIXTURES**

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- A. All preparation work (provision of holes, pipes etc.) shall be carried out in strict accordance with the fixture manufacturers requirements and shall be arranged such that pipe fittings, offsets & connections are kept to a minimum. All plumbing fixtures shall be securely fixed to the structure or their support system and shall be plumb & level. The fixtures & their plumbing connections shall be arranged to ensure the connections are not subject to any strain or load from the fixtures.

### 3.04 INSTALLATION OF FITTINGS

- A. All fittings shall be installed true & straight or where curved, shall follow the manufacturers recommendations to produce a smooth, fair & continuous radius. Any fittings exhibiting 'tool working' or surface finish damage shall be replaced. When positioning fixtures & fittings the contractor shall ensure that all items are central, or where in a range, consistent and symmetrical about architectural finishes as indicated on the drawings.
- B. Where fittings are concealed the contractor shall ensure that they are accessible for maintenance without affecting the structure or finishes.

### 3.05 PROTECTION

- A. The Contractor shall take all measures necessary to protect fixtures and fittings during construction. Any damaged fixtures and fittings shall be replaced by new equivalent units. Repairing of damaged units shall not be accepted.

All fixtures and fittings shall be finally cleaned and put into working order upon completion of construction. The Contractor shall be fully responsible for maintaining these items until the facility is finally handed over.

### 3.06 TOOLS

- A. The contractor shall supply any special wrenches or other devices necessary for servicing and maintaining the fixtures & fittings. The contractor shall supply 1 No. device for each 10 No. units installed.

END OF SECTION 15440

## SECTION 15450

### PLUMBING PIPING INSULATION

#### PART 1 GENERAL

##### 1.01 SCOPE OF SECTION

- A. This technical specification establishes the type and quality of materials and the standard of workmanship to be used in the supply and application of thermal insulation to plumbing piping.

##### 1.02 WORK INCLUDED

- A. The work includes the provision of all labour, materials and the performance of all operations in connection with the supply and application of thermal insulation as specified herein and where referred to on the Drawing.
- B. Coordination : The Contractor shall be responsible for the full coordination of the work of all trades.

##### 1.03 QUALITY ASSURANCE

- A. Manufacturer: Firms regularly engaged in the manufacturing of thermal insulation materials whose products have been in satisfactory use for a similar application for not less than 10 years.
- B. Installer : Firms regularly engaged and qualified in the application of thermal insulation materials with at least 5 years successful installation experience on projects of a similar nature.

##### 1.04 APPLICABLE CODES AND STANDARDS

- A. The thermal insulation products and all associated materials shall comply with the latest relevant British Standards in all respects.
- B. The following are the most commonly used and relevant British Standards associated with thermal insulation products and associated material. However, the Contractor shall ensure that all applicable British Standards are complied with whether listed here or not.

BS 476 Part 4 : Non-combustibility Test for Materials.

BS 476 Part 7 : Method for Classification of the Surface Spread of Flame of Products

BS 476 Part 20 : Method for Determination of the Fire Resistance of Elements of Construction.

BS 1485 : Specification for Zinc Coated Hexagonal Steel Wire Netting.

BS 3958 Part 3	:	Metal Mesh Faced Man-made Mineral Fibre Mattresses.
BS 3958 Part 4	:	Bonded Preformed Man-made Mineral Fibre Pipe Sections.
BS 3958 Part 5	:	Specification for Bonded Man-made Mineral Fibre Slabs.
BS 5422	:	Specification for the use of Thermal Insulation Materials.
BS 5970	:	Code of Practice for Thermal Insulation of Pipework and Equipment

## **PART 2 PRODUCTS**

### **2.01 GENERAL**

- A. For general applications the thermal insulation materials shall be made from materials which will not burn, but materials which are not entirely non-combustible may be accepted if they have self-extinguishing characteristics, the total mass of combustible materials is small and combustion does not produce dense smoke or toxic fumes. All material finishes shall conform to spread of flame classification class O. Such materials shall only be used with the prior permission of the Engineer.
- B. Insulation shall be rotproof, odourless, non-hygroscopic, shall not sustain vermin and shall not contribute to metal corrosion. Any finishes (or coverings) used shall not deteriorate with age or the effects of solar heat.
- C. Thermal insulation materials and their finishes shall be asbestos free and be suitable for continuous use throughout the range of operating temperatures and within the environment indicated.
- D. All insulating materials and associated products, sealants, tapes, adhesives, securing bands and protective cladding shall be as specified or equal and approved.

### **2.02 PLANT AND PIPEWORK INSULATION**

- A. Thermal insulation shall be pre-formed rigid sections or slabs, the basic material consisting of one of the following:
  - \* Rockwool mineral fibre (density 110-160 Kg/m<sup>3</sup>).
  - \* Pre-formed glass fibre sections (density 80-110 Kg/m<sup>3</sup>).

The insulation shall be manufactured from long stranded mineral fibres, resin bonded to form sections having uniform density and high compressibility. The preformed rigid insulation outside surface shall be smooth, unbroken, uniform, concentric and firm.

- B. Pipework insulation shall be high density rigid resin bonded preformed rockwool mineral fibre sections of the thickness specified. The insulation shall comprise of two

half sections with a factory applied reinforced aluminium foil covering hinging the two half mating sections for ease of installation. The covering shall have a 50mm side overlap of reinforced aluminium foil to enable the outside surface to be completely sealed.

- C. Where thermal insulation of plant is required the insulation shall be preformed rigid sections or slab. The material shall consist of long fine fibres (free from shot and coarse fibres) bonded with a temperature resistant resin. The density shall be a minimum of 48 Kg/m<sup>3</sup> and the surf shall have a factory applied reinforced aluminium foil finish.
- D. Thickness of insulation shall be determined in accordance with the following tables for the appropriate medium and the declared value of thermal conductivity of the insulation material at the relevant temperature.

When selecting the insulation thermal conductivity, the space available for the installation shall be thoroughly examined to ensure that the resultant thickness can be accommodated.

**TABLE 1**

**THICKNESS OF INSULATION FOR HOT WATER SERVICES**

DECLARED THERMAL CONDUCTIVITY (W/m°C)				
Size of Tube	Up to 0.040	0.041-0.055	0.056-0.070	
mm	Minimum thickness of insulation(mm)			
15 to 32	25	25	25	
40 to 50	25	32	32	
65 to 80	32	32	32	
100	32	32	38	38
125	32	38	44	44
150	38	44	44	44
Flat Surface	44	44	44	44

**TABLE 2**

**THICKNESS OF INSULATION FOR COLD WATER SERVICES**

DECLARED THERMAL CONDUCTIVITY (W/m°C)						
Pipework within Building				External Pipework		
Size of	Up to	0.041 to	0.056 to	Up to	0.041 to	0.056 to

tube	0.040	0.055	0.070	0.040	0.050	0.070
(mm)	Minimum thickness of insulation (mm)					
15 to 40	32	50	75	38	63	100
50 to 80	25	32	50	25	44	63
100 to 150	19	25	38	25	32	50
Flat Surfaces	19	25	38	25	32	50

### PART 3 EXECUTION

#### 3.01 STORAGE

- A. All thermal insulation materials shall be stored in their original packaging in such a manner as to prevent the ingress of dust or moisture. The height of the packages shall be restricted to prevent any deformation of preformed rigid sections.
- B. Flat sheet and rolled metal materials used for protective claddings shall be stored away from the ground surface, adequately covered and protected in a manner to prevent damage to the materials.
- C. All storage areas shall have adequate lighting to allow for the inspection of all materials.

#### 3.02 FIXINGS

- A. All mechanical fixings (rivets, screws) shall be as recommended by the manufacturer of the material being fixed. All mechanical fixings, sealants, tapes and adhesives shall be entirely suitable for the medium that they are being applied to and the application shall be fully in accordance with the manufacturers recommendations.

#### 3.03 PLANT AND PIPEWORK INSULATION

- A. Thermal insulation to pipework shall be carried out by specialists and strictly in accordance with this Specification. No thermal insulation shall be applied to pipework prior to witnessing of the pipework pressure test and only then after a full inspection and approval by the Engineer.
- B. Thermal insulation shall be applied to the following:-
  - (i) All pipework carrying hot fluids in circulation including flanges and bodies of valves on all sizes of pipework.
  - (ii) External distributing mains and fittings above ground and in ducts, chases and trenches including all valve bodies and flanges.



- (iii) Cold water pipework (including valve bodies and flanges) run above ground external to buildings and run in ducts, chases, roof spaces and elsewhere as indicated, to prevent shedding of condensation.

Insulation shall fit closely on and other surfaces without gaps be.

- C. The following lines not be insulated:
  - 1. Chromium-plated pipe to plumbing fixtures.
- D. All sections of the insulation shall be of the correct size and made for the type and grade of piping to which it is fitted and shall form a tight fit on the pipework after application of adhesive and lapping. Bends shall be formed by cutting a series of gussets in the pre-formed sections to form a continuous finish with the pipework. The valve bodies and flanges in plantrooms and those components within the entire pipework system 65mm dia and above shall be insulated with the same insulation as the accompanying pipework but contained within a removable aluminum box. Where a vapour seal is incorporated into the insulation, all joints shall be effectively sealed with approved sealing material and securely fixed.
- E. Each pre-formed rigid insulation section shall be butt jointed to the next, the joint being fully sealed with 75 mm wide aluminium tape. The preformed sections on domestic hot and cold water services shall be secured hard to the bracket where inserts are not used. The reinforced aluminium side overlap shall be sealed with a suitable adhesive or 75 mm wide aluminium tape. Outer coverings shall not come into contact with pipework and attachments.
- F. Each section of pre-formed insulation shall be screwed to the pipe by one of the following means:
  - \* Circumferential tie wires each formed from three turns of wire not less than 1 mm thick, spaced not more than 450 mm apart.
  - \* Circumferential bands of non-ferrous metal, plastic fibre or adhesive sheet.
  - \* Rigid insulation applied to cylinders and flat surfaces shall be secured with non-ferrous metal or plastic fixings.
- G. The insulation on pipework concealed from view within buildings will not require further protective cladding.
- H. Insulation on pipework exposed to view and within plantrooms shall be clad fully in a pre-formed aluminum stucco finish cladding 0.8 mm thick held in place by means of rivets or self tapping screws. All joints shall be sealed with a non-setting sealing compound.
- I. Insulation on pipework exposed to the outside atmosphere shall be clad with a covering of polyisobutylene sheet fixed with adhesive, lapped and solvent welded to form an impervious seal. At entries into buildings, the weatherproof insulation shall extend not less than 100 mm beyond the inner face of the wall and be sealed to the satisfaction of the Engineer.

3.04 PROTECTION

- A. The Contractor shall take all necessary measures to protect the works during construction. Any damaged sections of insulation shall be completely cut out and replaced with a new section. The vapour seal shall be repaired to ensure continuity.

All damaged sections shall be replaced at the Contractor's expense until the system is accepted and finally handed over.

END OF SECTION 15450

## SECTION 15451

### TANKS

#### PART 1 GENERAL

##### 1.01 SCOPE OF SECTION

- A. The work described in this section covers the support, installation and quality of materials and workmanship for the potable water storage tank installation.

##### 1.02 QUALITY AS

- A. Material and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of products that have been in satisfactory use for a period of ten years.
- B. Installer firms proposed for the installation of the storage tanks and equipment shall have been engaged for at least 5 years in the installation of tanks of a similar type, quality and scope as is required for this project.

##### 1.03 WORK INCLUDED

- A. Provision of all labour, materials, and the performance of all operations necessary for the supply and installation of potable water storage tank and equipment of the as specified herein and as detailed on the Drawings.
- B. Coordination: The Contractor shall ensure that the storage tanks are fully compatible with all trades, particularly those of the Civil, Mechanical and Electrical services, for successful installation and operation.
- C. Submittals: The Contractor shall submit to the Engineer for review and approval, all calculations and drawings for the equipment proposed and associated builders works to show that the plant as installed will meet all the specified criteria.

No works shall commence on the production of the package or associated site works until the design has received the approval of the Engineer.

##### 1.04 APPLICABLE CODES AND STANDARDS

BS 3792: Recommendations for the installation of automatic liquid level and temperature measuring instruments on storage tanks.

#### PART 2 PRODUCTS

##### 2.01 GENERAL

- A. For number and location of tanks refer to drawings.
- B. Galvanized steel water storage tank, Complies with Food and Drug Administration Regulations 21CFR 177.1520 (1) 3.1 and 3.2. All tanks shall have access panel. Where required tank shall have two level switches.

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- D. In accordance with the sites shown on the drawings each tank shall be provided with connections for the following:
1. Water inlet
  2. Vent pipe (with insect screen)
  3. Water outlet
  4. Water level alarm system
  5. Drain
  6. Access cover
  7. Over flow
  8. Float valves for concrete water tanks.
  9. Float switches for elevated tanks.
  10. PVC Puddle flanges for concrete water tanks.
  11. Anti-vortex plates for concrete water tanks.
  12. Stainless steel ladder for concrete potable water tank. With safety rail and safety cage.
  13. Aluminum ladder for concrete fire water tank. With safety rail and safety cage.

### **PART 3 EXECUTION**

#### 3.01 INSTALLATION OF TANKS

- A. Storage tanks to be installed in strict accordance with engineers instructions.

#### 3.02 INSPECTION OF TANKS AND TESTING

- A. Storage tanks: slowly fill with water to top water level and visually inspect for leaks.

#### 3.03 TANK ACCESSORIES

- A. Coordinate placement of tank accessories. set items level, plumb, and in alignment with adjoining work.
- B. Provide anchors and inserts in sufficient number for proper fastening of items. Embed anchors in concrete to accurately align metal work at proper level.
- C. Drill holes as required for bolts and screws in supports and in metal work. Conceal fasteners where possible.
- D. Provide joint sealant as required to set, seal and secure metal items.

END OF SECTION 15451

**SECTION 15455**

**PLUMBING PUMPS**

**PART 1 GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Booster and lifting pump set.
2. Submersible pumps.

B. Related Sections:

1. Section 16150 - Wiring Connections: Execution requirements for electrical connections to pumps specified by this section.
2. Section 16225 - Motors: Product requirements for motors for placement by this section.

1.2 REFERENCES

1. The pumps shall comply fully with the latest relevant International and British Standards in all respect.

The following are the most commonly used standards associated with pumps; however the contractor shall ensure that all applicable standards are complied with, whether listed here or not.

BS EN 16297:	Pumps. Rotodynamic pumps. Glandless circulators. General requirements and procedures for testing and calculation of energy efficiency index (EEI).
BS 4082:	Specification for external dimensions of vertical in line centrifugal pumps.
BS 5257:	Specification for horizontal and end suction centrifugal pumps.
BS EN 806-2:	Specifications for installations inside buildings conveying water for human consumption Design

1.3 PERFORMANCE REQUIREMENTS

- A. Provide pumps to operate at system fluid temperatures without vapor binding and cavitations, pumps are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

1.4 SUBMITTALS

- A. Drawings refer to 15010.

- B. Product Data: Submit certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements. Submit also, manufacturer model number, dimensions, service sizes, and finishes.

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- C. Manufacturer's Installation Instructions: Submit application, selection, and hookup configuration with pipe and accessory elevations. Submit hanging and support requirements and recommendations.
  - D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- 1.5 CLOSEOUT SUBMITTALS
- A. Operation and Maintenance Data: Submit installation instructions, servicing requirements, assembly views, lubrication instructions, and replacement parts list.
  - B. Maintain one copy of each document on site.
- 1.6 QUALIFICATIONS
- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum 10 years documented experience ,and with service facilities within the region of the project.
  - B. Installer: Company specializing in performing Work of this section with minimum 5 years documented experience.
- 1.7 PRE-INSTALLATION MEETINGS
- A. Administrative Requirements: Pre-installation meeting.
  - B. Convene minimum one week prior to commencing work of this section.
- 1.8 DELIVERY, STORAGE, AND HANDLING
- A. Product Requirements: Product storage and handling requirements.
  - B. Protect systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.
- 1.9 FIELD MEASUREMENTS
- A. Verify field measurements prior to fabrication.
- 1.10 WARRANTY
- A. Furnish five year manufacturer warranty for pumps.
- 1.11 EXTRA MATERIALS
- A. Furnish one set of mechanical seals for each pump.

## **PART 2 PRODUCTS**

### **2.1 IN-LINE CIRCULATOR PUMPS**

- A. Furnish materials in accordance with the applicable authority standards.
- B. Casing: Bronze rated for working pressure as indicated on drawings with stainless steel rotor assembly.
- C. Impeller: Bronze.
- D. Shaft: Alloy steel with integral thrust collar and two, oil lubricated bronze sleeve bearings.
- E. Seal: Carbon rotating against stationary ceramic seat.
- F. Drive: Flexible coupling.
- G. Performance: as indicated on drawings.
- H. Electrical Characteristics and Components: as indicated on drawings.

### **2.2 CLOSE COUPLED PUMPS**

- A. Furnish materials in accordance with the applicable authority standards.
- B. Type: Horizontal shaft, single stage, close coupled, radial split casing, for maximum working pressure as indicated on drawings.
- C. Casing: Cast iron, with suction and discharge gage ports, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge.
- D. Impeller: Bronze, fully enclosed, keyed to motor shaft extension.
- E. Shaft: Stainless steel.
- F. Seal: Carbon rotating against stationary ceramic seat, 107 degrees C maximum continuous operating temperature.
- G. Performance: as indicated on drawings.
- H. Electrical Characteristics: In : In accordance with Electrical Specifications.

### **2.3 BOOSTING PUMP SET**

- A. Furnish materials in accordance with the local and International Construction Specifications.

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- B. System: Packaged with vertical multi stage pumps, factory assembled, tested, and adjusted; shipped to site as integral unit; consisting of pumps, valves, pressure vessel (for boosting set) and copper piping, with control panel assembled on fabricated steel base with structural steel framework.
- C. The pumps shall be vertical multistage centrifugal pumps mounted on parallel on a common base. The pump construction shall be:
  - 1. Casing: cast iron.
  - 2. Shaft: stainless steel fitted with Tungsten Carbide intermediary bearings.
  - 3. Impeller: stainless steel.
  - 4. Seal: mechanical seal suitable for the full pressure and temperature range of the pump and shall be fitted with Carbon rotating face and Silicon Carbide stationary face.
- D. Controls and Instruments: Locate in NEMA 250 Type 1 general-purpose enclosure with main-disconnect interlocked with door. Fused circuit for each motor, magnetic starter with three overloads, control circuit transformer with fuse protection, selector switch for each pump. Low limit pressure switch, low pressure alarm light, running lights, current sensing devices, minimum run timers, manual alternation, and suction and discharge pressure gages.
- E. The pressure vessel (for boosting set) shall be Pre-charged Diaphragm type, stamped 125 psi (862 kPa) working pressure. The vessel will be supplied with a heavy duty butyl diaphragm. The vessel shall be supplied with a ring base, lifting rings and NPT system connection. An air charging valve connection (standard tire valve) shall be provided to facilitate adjusting pressure to meet actual system conditions. The tank shall be constructed and stamped in accordance with section VIII of the ASME Boiler & Pressure Vessel Code.
- F. Lead Pump: Operate continuously with duty pump operating on system demand. Upon lead pump failure, start next pump in sequence automatically. Time cycling of the two pumps shall be included.
- G. Time Delay Relay: Prevent lag pump short cycling on fluctuating demands.
- H. Thermal Bleed Circuit with Solenoid Valve: Prevent overheating during low demand.
- I. Low Pressure Control: Stop pump operation when incoming water pressure drops to atmospheric.
- J. Pump Switch: Permit manual or automatic operation.
- K. Valves: Each pump outlet: Furnish gate or butterfly valves on suction and discharge of each pump. Furnish check valve on each pump discharge.
- L. Pump shall operate upon pressure switch demand.
- M. Performance:
  - 1. As indicated in schedules.
- N. Electrical Characteristics: In accordance with Electrical Specifications.
  - 1. Disconnect Switch: Factory mount disconnect switch in control panel.
  - 2. Overload and dry run protection shall be provided.



## 2.4 SUBMERSIBLE SUMP PUMPS

- A. Furnish materials in accordance with International Construction Specifications.
- B. Type: Completely submersible, vertical, centrifugal.
- C. Casing: Cast iron pump body and oil filled motor chamber.
- D. Impeller: Single channel Cast iron closed.
- E. SHAFT: stainless steel shaft.
- F. Bearings: Ball bearings.
- G. Accessories: Oil resistant cord and plug for connection to electric wiring system.
- H. Servicing: Slide-away coupling consisting of discharge elbow secure to sump floor, movable bracket, guide pipe system, lifting chain and chain hooks.
- I. Controls: Motor control panel containing across-the-line electric motor starters with ambient compensated quick trip overloads in each phase with manual trip button and reset button, circuit breaker, control transformer, electro-mechanical alternator, hand-off-automatic selector switches, pilot lights, high water alarm pilot light, reset button and alarm horn. Furnish mercury switch liquid level controls, steel shell switch encased in polyurethane foam with cast iron weight for pump on each pump, pump off, and alarm.
- J. Performance:
  - 1. As per Schedules.
- K. Electrical Characteristics: In accordance with Electrical Specifications.
  - 1. Motors: In accordance with Electrical Specifications.
  - 2. Disconnect Switch: Factory mount disconnect switch in control panel.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Provide pumps to operate at specified system fluid temperatures without vapor binding and cavitations, which are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- B. Install long radius reducing elbows or reducers between pump and piping. Support piping adjacent to pump so no weight is carried on pump casings. For close coupled or base mounted pumps, install supports under elbows on pump suction and discharge line sizes 100 mm and over.
- C. Install pumps on vibration isolators and inertia base. Refer to relevant specification Section.
- D. Install flexible connectors at or near pumps.
- E. Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve, balancing valve, and shut-off valve on pump discharge.

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- F. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump so no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 100 mm and larger.
  - G. Provide air cock and drain connection on horizontal pump casings.
  - H. Provide drains for bases and seals.
  - I. Check, align, and certify alignment of base mounted pumps prior to start-up.
  - J. Install base mounted pumps on concrete housekeeping base and inertia base as per drawings.
  - K. Lubricate pumps before start-up.
  - L. All submersible pumps shall be installed on a concrete 100 mm base as per drawings.
- 3.2 FIELD QUALITY CONTROL
- A. Execution Requirements: Testing, adjusting, and balancing.
  - B. Inspect for alignment of base mounted pumps.
- 3.3 SCHEDULES:  
As per drawings.

END OF SECTION 15455

**SECTION 15500**

**HEATING, VENTILATION AND AIR CONDITIONING**

**PART 1 GENERAL**

1.01 SCOPE OF SECTION

- A. HVAC scope
- B. Basis of design
- C. Systems descriptions

1.02 HVAC SCOPE

- A. The Heating, Ventilation and Air Conditioning shall include the following systems and all systems and components shown of the drawings.
  - a) HVAC.
  - b) Ventilation systems.
  - c) Toilet mechanical ventilation.

1.03 BASIS OF DESIGN

A. DESIGN CRITERIA USED FOR HVAC CALCULATIONS

1. External ambient

Winter	:	0°C dry bulb
Summer	:	40 °C dry bulb, 22 WB
Site location	:	Wadi Mousa
Altitude	:	1130 m above sea level
Latitude	:	35.62° N
Longitude	:	35.38° E

The above summer design temperature does not apply to equipment operating ambient, which are given separately in this specification.

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### 2. Internal Conditions

#### a. Offices

Winter	:	21 °C
Summer	:	24 °C, 50% RH

### 3. Noise Criteria

Toilets: NC 40

Stores: NC 40

## **PART 2 PRODUCTS**

Not used

## **PART 3 EXECUTION**

Not used

END OF SECTION 15500

**SECTION 15513  
HVAC NOISE CONTROL**

**PART 1 GENERAL**

1.01 SCOPE OF SECTION

- A. This technical specification details the noise control requirements for the HVAC equipment, plant and systems.

1.02 WORK INCLUDED

- A. The work includes the provision of all labour material and the performance of all operations in connection with the supply and installation of HVAC noise control equipment.

1.03 APPLICABLE CODES AND STANDARD

The testing of all noise control equipment and the methods used in measuring the noise ratings of air conditioning plant and equipment shall be in accordance with the relevant sections of the following British standards, unless otherwise stated:-

BS 4718:1971        Methods of Test of silencers for Air Distribution Systems.

BS 2750:  
Parts 1-9-1980        Laboratory and Field Measurement of Airborne Sound Insulation of Various Building Elements.  
Recommendations for Field and Laboratory Measurement of Airborne and Impact Sound Transmission in Buildings.

BS 3638:1987        Method of Measurement of Sound Adsorption in a Reverberation Room.

BS 4773:  
Part 2:1976        Acoustic Testing.

BS 4856;  
Part 4:1978        Acoustic performance without Additional Ducting of Forced Fan Convection Equipment.

Part 5:19        Acoustic Performance with Additional Ducting of Forced Fan Convection Equipment.

BS 4857:  
Part 2:1978(1983)    Acoustic Testing and Rating of High Pressure Terminal Reheat Units.

BS 4954:  
Part 2:1978(1987)    Acoustic Testing and Rating of Induction Units.

BS 5643:1984        Glossary Refrigeration, Heating, Ventilating and Air Conditioning Terms.

1.04 SUBMITTALS

- A. Drawings - refer to 15010
- B. Calculations - manufacturers selection calculations justifying equipment proposed for specified parameters.

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- C. Product - full certified manufacturers data for each type of product.
- 1.05 OPERATION AND MAINTENANCE DATA
  - A. Comply with 15010
- 1.06 WARRANTY
  - A. Provide 24 months warranty in accordance with contract conditions.

## **PART 2 PRODUCTS**

### 2.01 ANTI-VIBRATION MOUNTINGS

- A. All items of rotating and reciprocating plant and equipment shall be isolated from the structure by the use of anti-vibration materials, mountings or spring loaded supports fixed to either concrete bases, inertia blocks or support steels as indicated.
- B. Centrifugal fans and motors within package units shall be isolated from the frame of the unit by suitable anti-vibration mountings. Fan discharge air connection shall be fitted with approved flexible connections internally isolating the fan scroll from the air-handling unit casing.
- C. Axial flow fans shall mounted on steel legs on diaphragm plates supported on neoprene in shear anti-vibration mountings, or suspended using spring loaded hangers to suit the application.
- D. Centrifugal pumps shall be mounted on inertia bases consisting of re-inforced concrete sub-base, anti-vibration mountings and concrete filled steel upper plinth. The contractor shall be responsible for issuing the steel upper plinth and mountings to the contractor for building-in.
- E. Pipework connections to circulating pumps, heating coils and other equipment shall be made with flexible connections as described in section of the specification.
- F. Pipework connecting to circulating pumps, and other equipment shall be supported by means of spring hangers for a distance of 100 pipe diameters from the point of connection to vibrating plant, as section of this specification.
- G. The construction of the anti-vibration mountings shall generally comply with the following: -
  - 1. Enclosed spring mountings (caged or restrained springs)

Each mounting shall consist of cast or fabricated telescopic top and bottom housings enclosing one or more helical steel springs as the principal isolation elements, and shall incorporate a built-in levelling device.

The springs shall have an outside diameter of not less than 75% of the operating height, and be selected to have at least 50% overload capacity before becoming coil-bound.

The bottom plate of each mounting shall have bonded to it a neoprene pad designed to attenuate any high frequency energy transmitted by the springs.

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Mountings incorporating snubbers or restraining devices shall be designed so that the snubbing damping or restraining mechanism is capable of being adjusted to have no significant effect during the normal running of the isolated machine.

### 2. Open spring mountings

Each mounting shall consist of one or more helical steel springs as the principal isolation elements, and shall incorporate a built-in levelling device. The springs shall be fixed or otherwise securely located to cast or fabricated top and bottom plates, and shall have an outside diameter of not less than 75% of the operating height, and shall be selected to have at least 50% overload capacity before becoming coil-bound.

The bottom plate shall have bonded to it a neoprene pad designed to attenuate any high frequency energy transmitted by the springs.

### 3. Neoprene-in-shear mountings

Each mounting shall consist of a steel top plate and base plate completely embedded in oil resistant neoprene. Each mounting shall be capable of being fitted with a levelling device, and bolt holes in the base plate and tapped holes in the top plate so that they may be bolted to the floor and equipment where required.

## 2.02 INERTIA BASES PUMPS

- A. The inertia base shall be an all welded mild steel channel frame the minimum depth of which shall be 1/12 of the longest span between isolator but not less than 150mm. filled with concrete the density of which shall be 2300kg/m<sup>3</sup>.
- B. The inertia base shall be sufficiently large to provide support for all parts of the equipment, including any components that overhang the equipment base, such as suction and discharge elbows on centrifugal pumps.
- C. The frame shall include pre-located equipment anchor bolts fixed into position and housed in a steel sleeve allowing minor bolt location adjustment.
- D. Isolator support brackets shall be welded into the corners of the base and suitably re-enforced for the load of the equipment and base.
- E. Additional reinforcing rods shall be provided at 200mm. centers to ensure the concrete and frame is adequately stiffened against distortion.
- F. The inertia base shall be provided with open type spring mountings selected by the contractor for the load and operating conditions.

## 2.03 FLEXIBLE CONNECTIONS

- A. Flexible connections shall be provided on all ductwork connections to fans, rotating plant and equipment isolated from structure on anti-vibration materials or mountings. Pipework and ductwork crossing building movement construction joints shall be installed with flexible connections.
- B. Flexible connections on ductwork to fans shall be a minimum/maximum free length of 100mm./200mm. respectively to minimise noise transmission and noise breakout. They shall be complete free from stress and shall not be required to accept any weight.
- C. Thicknesses and strengths of flexible connection materials shall be suitable to withstand the positive and negative fan pressures to which they will be

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- subjected to and shall not allow perceptible leakage. The materials shall be durable, non-flammable having good acoustical quality.
- D. Flexible connections shall be fitted to all pump suction and discharge connections, chillers and other centrifugal, reciprocating or vibrating equipment and where anti-vibration mounts and inertia basis are fitted.
  - E. Flexible connections shall be fitted to all heating coils water pipe work connections.
  - F. Flexible connections shall allow freedom of movement of plant in all planes.
  - G. Mating flanges to pipework flexible connections shall be of the smooth faced weld-neck type.

### **PART 3 EXECUTION**

- A. All moving plant, machinery and apparatus shall be statically and dynamically balanced at manufacturers works and certificates issued.
- B. Moving plant, machinery and apparatus including line equipment shall be isolated from the building structure.
- C. Electrical conduits and connections to all moving plant and equipment shall be carried out in flexible conduit and cables to prevent the transmission of vibration to the structure and nullify the provisions of anti-vibration mountings.
- D. All duct connections to fans shall incorporate flexible connections, except in cases where these are fitted integral within air handling units.
- E. Ductwork connections to the fan inlets/outlets shall be concentrically aligned so that the flexible connections are not subjected to any strain and not used as a means of correcting bad misalignment.
- F. All resilient acoustic-absorbing materials shall be non-flammable, vermin and rot proof and shall not tend to break up or compress sufficiently to transmit vibration or noise from the equipment to the structure.
- G. Where practicable, silencers shall be built into walls and floors to prevent the flanking of noise into the ductwork systems and their penetrations sealed in the manner previously described.

Where this is not feasible, the exposed surface of the ductwork between the silencer and the wall subjected to noise infiltration shall be acoustically clad as indicated.

Where silencers do not bridge plant room walls the ducting shall be covered with Revertex JPT020 sound barrier mat and 50mm. isophon 703 or equivalent between silencer and floor or wall, to prevent flanking.

END OF SECTION 15513



## SECTION 15780

### DX SPLIT AIR CONDITIONING UNITS

#### PART 1 GENERAL

##### 1.01 SCOPE OF SECTION

- A. This technical specification establishes the quality of materials and workmanship to be used in the supply and installation of Split air conditioning units.

##### 1.02 WORK INCLUDED

- A. Provision of all labour, materials and the performance of all operations in connection with the supply and installation of the packaged and room air condition as specified herein and shown on the drawings.
- B. Coordination: The Contractor shall be responsible for proper coordination of the work of all trades.
- C. Contractor shall allow to train client technical staff by equipment suppliers.
- D. All equipment selection and calculation related to AC unit should be submitted to client approval.

##### 1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of packaged and room air conditioning equipment and fittings whose products have been in satisfactory use in similar service for not less than 10 years.
- B. Installer: Firms regularly engaged in the installation of packaged and room air conditioning equipment of a similar quality and scope as this project for at least 3 years.

##### 1.04 APPLICABLE CODES AND STANDARDS

- A. The room air conditioners shall comply fully with the latest relevant International and British Standards in all respects.
- B. The following are the most commonly used standards associated with ducted split air conditioners, however the Contractor shall ensure that all applicable standards are complied with, whether listed here or not.

BS:3456 Part 2            -     Room Air Conditioners  
Section 2.34

BS: 2852                -     Testing for Rating of Room Air Condition

BS: 5491                -     Testing Unit Air Conditioners Above 7Kw Capacity

NEC Article 44         -     Air Conditioning and Refrigerating Equipment.

ISO R859                -     Testing and Rating Room Air Conditioners

ARI 210                 -     Unitary Air Conditioning Equipment

ARI 270                 -     Sound Rating of Outdoor Unitary Equipment

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- 1.05 ARI 360 - Commercial Industrial Air Conditioning Equipment.  
SUBMITTALS
- A. Drawings refer to 15010
  - B. Products: Submit full manufacturers data for every item.
  - C. The unit capacity shall be sized and selected at medium speed..

### 1.06 OPERATION AND MAINTENANCE DATA

- A. Comply with 15010

### 1.07 WARRANTY

- A. Provide 60 months warranty in accordance with contract conditions.

## PART 2 PRODUCTS

### 2.01 WALL MOUNTED DX SPLIT SYSTEM AIR CONDITIONERS

- A. Direct Expansion (DX) split system air conditioning units shall be installed as indicated on the drawings and shall be complete with all required refrigerant piping, temperature controls and all other necessary ancillary items.
- B. The units shall deliver the design cooling capacity at the external ambient specified. The units shall be suitable for continuous operation with external ambient temperature at 45°C.
- C. Controls shall be factory wired and completely enclosed within the unit. All operating controls shall be located in a single area. Adjustable thermostats shall automatically cycle the compressor to maintain space conditions and the sensing element shall extend across the complete face of the cooling coil.
- D. Condensate removal shall be by means of gravity drainage.
- E. Evaporator and condenser coils shall be of copper tube construction with aluminum fins and additional anti corrosion coating suitable for salty spray atmosphere.
- F. Compressor motor shall be 2 pole, permanent split capacitor type protected against both thermal and electrical overload.
- G. Filters shall be washable type easily accessible and shall cover the full unit area of recirculated air. Air filters may be nylon fibre, glass fibre cellular plastics material and shall have a minimum efficiency of 80% when tested in accordance with BS 2831 Test Dust No. 3.
- H. Refrigerant stop valves which incorporate a spindle gland shall be serviceable with the valves "in situ".
- I. Gas line insulation shall be carried out using 19 mm thickness of a cell, foamed plastic, tubular pipe insulation. Tape all joints to form a good vapour seal, then wrap with glass cloth and paint with two coats of approved vapour seal.
- J. The evaporator/fan coil section shall be ceiling, wall or floor standing and complete with concealed control panel and finishes as indicated on the drawings.
- K. The Cassette units shall be Round flow

- L. The control panel shall have at least the following functions:
  - 1. On/Off/Cool Control
  - 2. Low/High cooling control
  - 3. Adjustable Thermostat
  - 4. Air discharge direction control On/Off

### **PART 3 EXECUTION**

#### **3.01 PRODUCT STORAGE AND HANDLING**

- A. All products shall be delivered in manufacturer's original protective packaging.
- B. All products shall be inspected at time of delivery for damage and for compliance with Specifications.
- C. All products that are found to be damaged, or not in accordance with the Specifications shall immediately be repaired or removed from the site and replaced. Repairs shall not be undertaken before Engineer's review of the Contractor's proposed action.
- D. All products shall be handled and stored as recommended by manufacturer to prevent damage and deterioration.
- E. The Contractor shall supply handling equipment such a lifting beams, reinforced canvas slings, protective paddings, struts, cradles, etc., required to handle products without damaging hardware or linings and coatings.
- F. Comply with Section 01600

#### **3.02 INSTALLATION**

- A. All units mounted externally shall have a raised concrete base with a minimum height of 100mm above surrounding surfaces. The base shall be sloped to provide natural drainage and ensure that ponding does not occur under the unit.
- B. Each unit of whichever type shall be complete with a local electrical disconnect switch.
- C. The units shall be of the sizes, capacities, duties and types indicated on the drawings and shall be installed in strict accordance with the manufacturers requirements.
- D. Each outdoor unit shall be installed on a vibration isolation base as per relevant specification section.

END OF SECTION 15780

## SECTION 15856

### AIR MOVERS: CENTRIFUGAL AND AXIAL

#### PART 1 GENERAL

##### 1.01 SCOPE OF SECTION

- A. This technical Specification establishes the type and quality of materials and the standard of workmanship to be used in the supply and installation of Air movers.

##### 1.02 WORK INCLUDED

- A. The work includes the provision of all labour, materials and the performance of all operations in connection with the supply and installation of Air movers as specified herein and where referred to on the Drawings, and schedules.
- B. Coordination: The Contractor shall be responsible for the full coordination of the work of all trades.

##### 1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of Air movers whose products have been in satisfactory use for a similar application for not less than 10 years.
- B. Installer: Firms regularly engaged and qualified in the installation of Air movers with at least 5 years successful installation experience on projects of a similar nature.

##### 1.04 APPLICABLE CODES AND STANDARDS

- A. The Air movers and all associated materials and workmanship shall comply fully with the latest relevant British Standards in all respects.

The following are the most commonly used and relevant British Standards associated with fan products and associated materials. However, the Contractor shall ensure that all applicable British Standards are complied with, whether listed here or not.

BS: 848 - Fans for general purposes.

BS: 4675 - Mechanical vibration in rotating machinery.

BS: 5285 - Specification. Performance of a.c. electric ventilating fans and regulators for non-industrial use.

##### 1.05 SUBMITTALS

- A. Drawings refer to 15010
- B. Calculations - submit fan head calculations based on Contractors working drawings.
- C. Products - submit full manufacturers data for every unit and component.

##### 1.06 OPERATION AND MAINTENANCE DATA

- A. Comply with 15010

1.07 WARRANTY

- A. Provide 60 months warranty in accordance with contract conditions.

1.08 EXTRA MATERIALS

- A. Comply with Section 15010
- B. Supply one spare set of drive belts for each fan.

**PART 2 PRODUCTS**

2.01 GENERAL

- A. Values of the resistance to airflow of items of equipment, ductwork and/or the total distribution system indicated in the contract documents are approximate. It shall be the responsibility of the Contractor to verify these values based on the equipment offered and provide fans capable of delivering the required air volume when operating against the actual total system resistance. Fans shall be tested in accordance with the requirements of BS848 and shall be selected to give the air volume flow rate and sound power level specified in the contract document.
- B. All fans shall be constructed to a fully developed design and shall be capable of withstanding the pressures and stresses developed during continuous operation at the selected duty. Additionally, all belt driven fans shall be capable of running continuously at 20 per cent in excess of the selected duty speed. Fan and motor assemblies shall be selected to allow a 10 percent increase in fan duty by a change of belts and pulleys only. External pressure shall increase with the "square-law", and shall be overcome.
- C. Fans shall be installed using bolts, nuts and washers with all "as cast" bearing surfaces for bolt heads and washers counterfaced. Holding-down bolts for fans and motors shall be provided with means to prevent the bolts turning when nuts tightened. Anti-vibration mountings shall be provided. Fans heavier than 20 Kg. shall be provided with eyebolts or other purpose made lifting facilities.
- D. The shaft and impeller assembly of all centrifugal, axial flow and mixed flow fans shall be statically and dynamically balance. All propeller fans shall be statically and dynamically balanced where the impeller diameter is 750mm or greater. Where indicated, limits of vibration severity shall be in accordance with BS 4675 Part 1.
- E. Fan bearings shall be of air handling, heavy duty, grease lubricated, selected for a basic rating life  $L_{10}$  of 100,000 hours at maximum speed and horsepower. The bearing type shall be suitable for the installed attitude of the fan. They shall be grease/oil ball and/or roller type or alternatively oil lubricated sleeve type.
- F. All bearing housings shall be precision located in position and arranged so that bearings may be replaced without the need for realignment. Bearing housings shall be protected against the ingress of dust and, where fitted with greasing points, they shall be designed to prevent damage from over-greasing. For grease lubricated systems, the bearings shall be provided with grease in amount and quality recommended by the bearing manufacturer. For oil lubricated systems, the housings shall provide an adequate reservoir of oil and shall include a filling plug and be oil tight and dust proof. Systems other than total loss types shall include an accessible drain plug. All bearing lubricators shall be located to facilitate maintenance.
- G. Where fans are required to handle toxic, corrosive, moisture laden, flammable, explosive or high temperature gases the materials of construction shall be selected to ensure suitability and all relevant safety regulations shall apply. Bearings and

lubrication arrangements shall be suitable for the prevailing conditions. Where a protective coating is required for use with corrosive gases, the coating shall cover all parts of the complete fan, motor and casing assembly which are in contact with the corrosive gases. No fan shall be installed if the protective coating has been damaged in any way. Impellers shall be of coated steel, stainless steel or aluminium or plastics as indicated.

- H. Motors shall be totally enclosed, suitable for 380 volts, 3-phase, 50 Hertz electrical supply or 220 V single phase, 50 Hertz electrical supply as indicated on the drawings. Motors for general use shall be provided with Class F insulation as a minimum standard and be suitable for running continuously in ambient temperatures of 50°C. Smoke handling fans shall have temperature ratings shall be as specified.. Parking exhaust fans shall be suitable for smoke clearance.

## 2.02 CENTRIFUGAL FANS

- A. Centrifugal fans for high and medium velocity systems (defined within HVAC specification DW 142) shall be backward bladed type.
- B. Where indicated, centrifugal fans consuming more than 7.5 kw at the fan shaft shall be the backward bladed type having a fan total efficiency not less than 75%.
- C. Fan casings shall be constructed to permit withdrawal of the fan impeller after fan installation. Fans other than those in the air handling units shall be provided with flanged outlet connections and spigoted inlet connections unless otherwise indicated, except that for negative pressures greater than 500 Pa, inlet connections shall be flanged.
- D. A plugged drain point shall be fitted at the lowest point in fan casings.
- E. Permanent indication shall be provided to show the correct direction of rotation of the fan impeller. Fan casings shall be provided with removable access panels which shall incorporate purpose made air seals. The sizes of access panels shall be such as to facilitate cleaning and maintenance of the impeller.

Impellers shall be of mild steel or aluminium alloy of riveted, welded or other approved construction, with spiders or hubs of robust design.

## 2.03 AXIAL FLOW FANS

- A. Axial flow fan casings shall be rigidly constructed of mild steel or aluminium alloy, stiffened and braced where necessary to obviate drumming and vibration. Mounting feet shall be provided where necessary for bolting to a base or to supports. Inlet and outlet ducts shall terminate in flanges to facilitate removal. For in-duct mounting fans, the length of the fan casing shall be greater than the combined length of the impeller(s) and motor(s) and electrical connections to the motors shall be through an external terminal box secured to the casing.
- B. Impellers shall be of steel, aluminium or plastics and the blades shall be secured to the hub, or the blades and the hub shall be formed in piece. The hub shall be keyed to the shaft. Blades shall be aerofoil section or laminar and capable of pitch adjustment where indicated.
- C. Axial flow fans shall be complete with spring anti-vibration mountings and revertex type flexible inlet and outlet ductwork connections. Inlet and outlet cones shall be supplied where free air inlets or outlets are indicated on the drawings and shall be protected using galvanized wire mesh guards, 1.2mm diameter wire with 25mm mesh.

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- D. Where axial flow fans are driven by motors external to the casings of the fans, drive guards shall be provided. Unless otherwise indicated, a guard is not required for any part of a drive which is inside the fan casing. An access panel with purpose made air seal shall be provided in the fan casing. The access panel shall be sized to facilitate maintenance.
- E. Smoke handling fans shall have temperature ratings as specified.

### 2.04 BIFURCATED AXIAL FLOW FANS

- A. Bifurcated axial flow fan casings shall be rigidly constructed of mild steel or aluminium alloy, stiffened and braced where necessary to obviate drumming and vibration. Mounting feet shall be provided where necessary for bolting to a base or to supports. Inlet and outlets ducts shall terminate in flanges to facilitate removal. For in-duct mounting of fans the length of the fan casing shall be greater than the combined length of the impeller(s) and motor(s) and electrical connections to the motors shall be through an external terminal box secured to the casing.
- B. Impellers shall be fixed pitch cast iron and shall be secured to the hub. The hub shall be formed in one piece and be keyed to the shaft.
- C. Bifurcated axial flow fans shall come with spring anti-vibration mountings and revertex type flexible inlet and outlet ductwork connections. Inlet and outlet cones shall be supplied where free air inlet or outlets are indicated on the drawings and shall be protected using galvanized wire mesh guards, 1.2mm diameter wire with 25mm mesh.
- D. Bifurcated axial flow fans shall be driven by motors contained within a separate casing within the main fan casing. The motor shall be completely separated from the air stream and shall be of the totally enclosed squirrel cage induction type, fitted with ball bearings.

### 2.05 CABINET OR DUCT MOUNTED TOILET EXTRACT UNITS

- A. The fans shall be centrifugal high efficiency, forward curved, and shall meet the appropriate requirements of the preceding clauses relating to fans generally.
- B. All fans shall have permanent direction arrows to indicate correct rotation.
- C. Fans and motors shall be mounted on a frame or support base and the complete assembly shall be isolated from the casing to prevent the transmission of vibration.
- D. Fan cabinets shall be constructed from aluminium alloy or galvanized sheet metal and shall allow fan withdrawal and include access panels for all maintenance requirements.

### 2.06 WINDOW AND WALL MOUNTED FANS

- A. Toilet and similar small extract fans of this type shall be plastic construction, incorporating back draught damper, mounting ring or sleeve as required.
- B. Units shall be suitable for operation in a sand laden atmosphere and have a suitable cowl preventing ingress of sand laden air directly into the fan.

### 2.07 CABINET OR DUCT MOUNTED FRESH AIR UNITS

- A. The fan shall be centrifugal high efficiency belt driven in-line type. The fan wheel shall be centrifugal backward inclined, constructed of aluminum.

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- B. The fan housing shall be constructed of heavy gauge galvanized steel or Aluminum alloy and shall include duct mounting collars. Also the fan housing shall allow fan withdrawal and include access panels for all maintenance requirements
- C. Motors shall be heavy duty ball bearing type, carefully matched to the fan load and furnished at the specified voltage, phase and enclosure. Motors and drives shall be mounted out of the air stream. Motors shall be readily accessible for maintenance.
- D. Fan bearings shall be of air handling, heavy duty, grease lubricated, selected for a basic rating life  $L_{10}$  of 100,000 hours at maximum speed and horsepower. The bearing type shall be suitable for the installed attitude of the fan. They shall be grease/oil ball and/or roller type or alternatively oil lubricated sleeve type.
- E. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
- F. All fans shall bear the AMCA Certified Ratings Seal for both sound and air performance. All fans shall have permanent direction arrows to indicate correct rotation.
- G. Fans and motors shall be mounted on a frame or support base and the complete assembly shall be isolated from the casing to prevent the transmission of vibration.
- H. The fan shall include filter Box section with filter guides, access doors from both sides. Filter Media shall be UL 900 listed.

### 2.08 JET FANS

- A. Configuration: Centrifugal Induction Fan, Direct drive with galvanized steel housing, 4mm thick, painted RAL 3020 red or off-white. Suitable for ceiling fixing.
- B. Two Speed motor 2900/1450 RPM, Uni-Directional.
- C. Manufactured and tested to European Standard EN 12101-3/2002. Fan and motor assembly suitable for 300°C/2 hours.
- D. Impeller: Cast aluminum, statically and dynamically balanced.
- E. Guide Vanes: Furnish on outlet with guard.
- F. Inlet Cone: Made of hot dipped galvanized steel.
- G. Silencers: Furnish on inlet and outlet of hot dipped galvanized steel constructed from 1.5mm pre-galvanized perforated sheet steel.\
- H. Motor: Totally enclosed fan cooled, IP55 protection, class H insulation.
- I. Isolator Switch: Externally mounted and wired, Lockable type, IP65.
- J. Sound Level: 40/55 dB (A) at 1m/45° in the free field.
- K. Fan Efficiency: Minimum 75%.
- L. Provide computational fluid dynamic simulation for jet fans to verify smoke extraction in case of fire.

## PART 3 EXECUTION

### 3.01 STORAGE

- A. Fans shall be stored in a well lit containers, covered to prevent ingress of dirt and clearly marked with location for ease of identification.
- B. Small fans shall be stored on shelving in a manner that will minimize the risk of damage.

### 3.02 INSTALLATION



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- A. All fans shall be installed in accordance with the manufacturers' instructions and in the locations shown on the drawings.
- B. In-line fans shall be supported independently of the ductwork system.
- C. All transit packaging shall be removed from fan/motor assemblies at the installation stage.
- D. Roof mounted fans shall be mounted on purpose made curbs and fully weathered.

END OF SECTION 15856

## SECTION 15890

### DUCTWORK

#### PART 1 GENERAL

##### 1.01 SCOPE OF SECTION

- A. This technical Specification establishes the type and quality of materials and the standard of workmanship to be used in the supply and installation of Metal Ductwork.

##### 1.02 WORK INCLUDED

- A. The work includes the provision of all labour, materials and the performance of all operations in connection with the supply and installation of metal ductwork as specified herein and where referred to on the Drawings.
- B. Coordination: The Contractor shall be responsible for the full coordination of the work of all trades.

##### 1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the factory fabrication of Metal Ductwork whose products have been in satisfactory use in a similar application for not less than 10 years.
- B. Installer: Firms regularly engaged and qualified in the installation of Metal Ductwork with at least 5 years successful installation experience on projects of a similar nature.

##### 1.04 APPLICABLE CODES AND STANDARDS

- A. The Metal Ductwork and all associated materials and workmanship shall comply fully with the latest relevant standards in all respects.
- B. The following are the most commonly used and relevant British, American and other Standards for Metal Ductwork and associated materials. However, the Contractor shall ensure that all applicable standards are complied with whether listed here or not.

1. The SMACNA (Sheet Metal and Air Conditioning Contractors' National Association, Inc.) duct manual and sheet metal construction for ventilating and air conditioning systems
2. Low Pressure Duct Construction Standards, 5th ed. (SMACNA).
3. Rectangular Industrial Duct Construction Standards. (SMACNA)
4. The ASHRAE handbook published by the American Society of Heating, Refrigerating and Air Conditioning Engineers Inc. - Duct Construction
6. ASTM Standard A525 : Hot Dipped Galvanized Steel Sheets
7. Standard for the Installation of Air Conditioning and Ventilating Systems (National Fire Protection Association, ANSI/NFPA 90A-93).
8. Standard for the Installation of Air Conditioning and Ventilating Systems (National Fire Protection Association, ANSI/NFPA 90A-93).
9. Standard for the Installation of Warm Air Heating and Air Conditioning Systems (National Fire Protection Association, ANSI/NFPA 90B-93).

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### 1.05 SUBMITTALS

- A. Drawings refer to 15010
- B. Calculations - refer to 15010.  
Fan head calculations shall be submitted to the engineer for approval based on Contractor ductwork working drawings.
- C. Products - Typical duct section and fittings to demonstrate integrity of construction.
- D. Full details of air test procedures.

### 1.06 OPERATION AND MAINTENANCE DATA

- A. Comply with 15010

### 1.07 WARRANTY

- A. Provide 12 months warranty in accordance with contract conditions.

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. All figure numbers referred to throughout this ductwork specification relate to those contained in SMACNA.

All ductwork shall be manufactured from hot-dip galvanised steel sheet G90 coating type or equal in accordance with ASTM specification for low, medium and high pressure / velocity air systems.

- C. Ductwork shall be manufactured to the sizes detailed on the drawings, however where ductwork is to be internally lined the ductwork size shall be increased to compensate for the lining thickness.
- D. The interior surfaces of all ductwork shall be smooth. No sheet metal parts, tabs, angles, or similar shall project into the air stream for any reason unless specified to do so. All seams and joints shall be external.
- E. The minimum nominal sheet thickness for any ductwork shall be 0.8 mm for internal systems with the longer duct size up to 1000mm. Where the longer duct size exceeds 1000 mm the nominal sheet thickness shall be 1.0 mm.
- F. The Contractor shall ensure that the choice of gauge thickness for ductwork and the stiffening provision is such that the ductwork installation does not drum or vibrate. Single stiffeners shall be used as illustrated in SMACNA

Ductwork performance standards shall be as follows:-

Ductwork system	/Velocity classification	Air Leakage
Toilet extract ventilation ductwork	Medium	Class "B"
Car park supply and exhaust ventilation ductwork	Medium	Class "A"

- H. All ductwork operating at pressures classified as "High" and "Medium" pressure in the table above shall be tested to establish conformity with leakage limits set out in SMACNA and in accordance with procedures described.

Additionally samples of straight duct beads and tees on low, medium and high velocity ductwork systems should be selected and pressure tested during erection to demonstrate the adequacy of jointing methods.

- I. All jointing and construction methods shall be approved by the Engineer.
- J. Approved sealant shall be used on all ductwork longitudinal seams. The sealant can be included in the seam during manufacture and applied as an edge sealant.
- K. Button punch snap lock longitudinal joints shall not be used.
- L. Particular attention shall be given to ensuring that cross jointing methods are suitable for the specified pressure rating. Cross joints shall generally be flanged and corner treatment shall be such that corners pull-up true and square and do not leak. An approved liquid or mastic sealant shall be used on all cross joints.
- M. Aerofoil section turning vanes shall be used on all 90° square bends. Turning vanes shall be securely attached at each end either to the duct or to internal runners and the runners fastened to the duct by mechanically-closed rivets or bolts at 150mm maximum spacing. Turning vanes in twin bends in which the widths of the straight section and branch differ shall be set so that the leading and the trailing edges of the turning vanes are parallel to the duct axis.
- N. Change shapes that maintain the cross sectional area shall have sides where the slope does not exceed 22.5° on any side. Should it be necessary to reduce the cross sectional area the slope shall not exceed 15° on any side and the reduction in area shall not exceed 20%. In this instance the approval of the Engineer shall be sought prior to manufacture.
- O. The slope of expansions and contractions shall not exceed 22.5° on any side unless it is unavoidable, in which case splitters shall be provided to bisect the angle between the sloping side and the centre line of the duct.
- P. Ductwork connections to plant and equipment (eg. heating coils,) shall, in the case of bolted flanges, be provided with matching flanges of similar size and thickness. Sheet metal returned flanges shall not be permitted.
- R. The ductwork sizes indicated on the drawings are nominal, therefore for socket and spigot joints the actual dimensions of ductwork and fittings shall be correctly related so that when installed the joint shall be effectively sealed.
- S. Bends shall be either segmented with swaged ends, or in the case of ductwork 400mm diameter and below, pressed bends of the long radiused type shall be acceptable.
- T. Tapers of the concentric type shall be manufactured with an angle not exceeding 15°. Tapers of the eccentric type shall have angles not exceeding 30°.
- V. Hangers and supports for ductwork systems shall generally comply with DW 142 Part 6. Primary fixings into the building structure shall be subject to approval by the Engineer.
- U. Ductwork hangers and supports shall be adjustable for height, spaced to ensure adequate support and where practicable, fitted at each ductwork joint or spaced at not more than the maximum centres as in tabulated in SMACNA for rectangular,

circular and flat oval horizontal ducting. Securing of formed brackets to corners of ductwork as a means of suspension shall not be permitted.

- V. Supports for vertical ductwork in buildings shall be generally located at each floor slab but subject to a maximum spacing of 4 metres.
- W. All ductwork shall be securely supported from the building structure but inert packing material shall be provided between ducts and supports to prevent direct contact of the ducting with the structure.
- X. Thermal insulators shall be installed between sheet metal ductwork carrying conditioned air and the support steelwork as described in this specification and as shown on the drawings.

### **PART 3 EXECUTION**

#### **3.01 STORAGE**

- A. Ductwork shall be either stored on purpose made racks of welded construction, or in a dry open area stored clear of the ground.
- B. All open ends of ductwork shall be sealed with polythene sheeting to prevent the ingress of dirt.
- C. Small ductwork sections shall not be stored within larger sections except in the case of circular ducts.
- D. Ductwork shall not be stacked in a manner that will result in damage to or deform of the sections will occur.
- E. All ductwork shall be stored with an identification label indicating the piece number, size and location in which it is to be installed.

#### **3.02 FIXINGS**

- A. Mechanically closed rivets shall be used strictly in accordance with the manufacturers recommendations with regard to use, size and clearance drill size.
- B. Bolts, nuts and washers shall be used for flanged sections of ductwork and shall be of mild steel protected by electro galvanizing, cadmium plating or a similar approved finish.
- C. Self tapping screws shall be used subject to the approval of the Engineer, in instances where other types of fixing is not practical.
- D. Welding shall not be permitted on galvanized sheet steel materials.

#### **3.03 GENERAL INSTALLATION**

- A. Ductwork shall be installed generally as indicated on the drawings subject to full coordination and fully in accordance with the SMACNA manuals referred to in Part 2.0.
- B. Where sets and final plant connections are required site measurements shall be taken to establish dimensions prior to manufacture.

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- C. All ductwork joints shall be fitted with the recommended minimum number of fixings, cleats or clamps. Sealants shall be used at all joints.
- D. Branches shall be installed off straight sections of ductwork and not off taper sections.
- E. Ductwork expansions shall be made upstream of a branch connection and contractions downstream of a branch connection.
- F. Concentric tapers on circular ductwork shall be used in preference to eccentric tapers. The latter shall be used only where it is necessary to offset the ductwork centre line.
- G. Particular regard must be paid to the prevention of duct movement, with consequent noise, potential leakage and strain upon flexible connections.
- H. Attention shall be given to the installation of long runs of air ducts to the direction of expansion or contraction movement due to thermal change, towards flexible inserts provided for the purpose of absorbing such movement.
- I. Test holes shall be provided in all main ducts and branches for airflow measuring. Test holes shall be neatly formed and fitted with removable type airtight plastic plugs.
- J. Care shall be exercised to ensure that no edges protrude into the airways, and that all spigots (especially on high velocity systems) are well matched so that a smooth airflow is achieved throughout the length of the ducting. Any section of ductwork causing noise due to poor construction shall be removed and reinstated at the Contractor's expense.
- K. Due consideration shall be given to the space required for all other services and allowance made for the thickness of thermal insulation.
- L. Air-leakage testing shall be carried out progressively, to the requirements for the particular pressure classification of the system in accordance with SMACNA procedures.
- M. All testing, balancing and commissioning shall be in accordance with the relevant section of this specification.

END OF SECTION 15890

## SECTION 15910

### DUCTWORK ACCESSORIES

#### PART 1 GENERAL

##### 1.01 SCOPE OF SECTION

- A. This Technical Specification establishes the type and quality of materials and the standard of workmanship to be used in the supply and installation of Ductwork Accessories.

##### 1.02 WORK INCLUDED

- A. The work includes the provision of all labour, materials and the perform of all operations in connection with the supply and installation of Ductwork Accessories as specified herein and where referred to on the Drawings.
- B. C: The Contractor shall be responsible for the full coordination of the work of all trades.

##### 1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of Ductwork Accessories whose products have been in satisfactory use for a similar application for not less than 10 years.
- B. Installer: Firms regularly engaged and qualified in the installation of Ductwork Accessories with at least 5 years successful installation experience on projects of similar nature.

##### 1.04 APPLICCODES AND STANDARDS

- A. The Ductwork Accessories and all associated materials and workmanship shall comply fully with the latest relevant British Standards HVCA DW/142 specification for sheet metal ductwork and other apcodes and standards in all respects.
- B. The following are the most commonly used relevant British Standards and other applicable codes and standards associated with Ductwork Accessories and associated materials. However, the Contractor shall ensure that all applicable standards are complied with whether listed here or not.

BS 476  
(Part 7) - Method for Classification of the Surface Spread of Flame of Products.

BS 476  
(Part 8) - Test Methods and Criteria for the Fire Resistance of Eof Building Construction.

BS 6821 - Methods for Aerodynamic Testing of Dampers and Valves.

BS 8233 - Code of Practice for Sound Insulation and Noise Reduction for Buildings.

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SMACNA - Duct work Construction

CP 413 - Code of Practice for Ducts for Building Services.

NFPA 90A - National Fire Protection Association - Standard for the Installation of Air Conditioning and Ventilating Systems.

### 1.05 SUBMITTALS

- A. Drawings refer to 15010
- B. Products: Samples of access doors, fire dampers, attenuators, sealants to be submitted for approval.
- C. Manufacturers data for every component to be submitted for approval.

### 1.06 OPERATION AND MAINTENANCE DATA

- A. Comply with 15010

### 1.07 WARRANTY

- A. Provide 12 months warranty in accordance with contract conditions.

## **PART 2 PRODUCTS**

### 2.01 VOLUME CONTROL DAMPERS

- A. All dampers shall be sufficiently rigid to prevent fluttering. Unless otherwise indicated the air leakage past dampers in the fully closed position shall not exceed 5% of the maximum design air flow in the duct.
- B. All duct volume control dampers shall be fitted with locking devices and position indicators.
- C. Manual dampers shall be provided for the proper balancing control and isolation of the ductwork system.

These shall be of the multi-leaf opposed blade type. Each damper comprising narrow width low profile aerofoil blades.

- D. Each leaf of a multi leaf damper shall comprise of a low profile aspect ratio aerofoil galvanised steel blade. The blades shall be provided with a totally enclosed galvanised steel reinforced locking rod. Each blade shall be connected to low pressure angle toothed gears in galvanised steel with brass bearings. The gear drive assembly shall be positioned totally out of the air stream in a totally enclosed galvanised steel dustproof control box which shall be externally mounted. The frame shall comprise of a galvanised steel formed inner frame and a roll-formed zintec steel outer frame having integral flanges, pre-punched with elongated holes for connection to the adjoining ductwork.

Quadrants and operating handles shall be of die-cast aluminium with the words 'OPEN' and 'SHUT' cast on the quadrant. Quadrants shall be securely fixed and the damper spindles shall be close fitting in the quadrant hubs to prevent any damper movement when the damper levers are locked.



## 2.02 FIRE/SMOKE DAMPERS

- A. Fire/smoke dampers shall conform in their entirety with NFPA 90A and shall meet the fire damper standard detailed in the manual of the Sheet Metal and Air Conditioning Contractors, National Association Inc. (SMACNA).
- B. Each fire damper shall have at least the same standard of fire resistance as the wall or floor through which the duct passes or where applicable, the fire rating of fire-clad ductwork abutting it. Unless otherwise indicated it shall have a fire resistance rating of 2 hours. When a fire resistance rating of 4 hours is required either 2 dampers, mechanically connected or a single damper having a fire resistance rating of 4 hours shall be provided.
- C. All dampers except where indicated for solenoid and motorised actuation shall have the blades housed in an enclosure located out of the air stream cross section. Connection shall suit the particular duct size with spigot or flanged ends as determined by the operating pressure/velocity and physical dimensions of the associated system ducting.
- D. Provide fire dampers of 16 gauge stainless steel with 100% interlocking joints to form a continuous steel curtain when closed.
- E. The damper shall be housed in a corrosion-resistant casing constructed to avoid distortion due to stress in fire conditions. Provision shall be made to accommodate expansion of the damper blades within the casing in fire conditions. A fire damper shall also incorporate provision for expansion in the form of an installation frame within the surrounding structure together with lugs for building into the structure.
- F. Provide out of the air stream positive closure stainless steel constant tension springs on all fire dampers.
- G. Each fire damper casing shall be clearly marked with a permanent indication of the correct fixing attitude of dampers, the direction of air flow and the side at which the access/maintenance opening shall be located.
- H. Local open/shut indication shall be affected by means of a position indicator for false ceiling installations.
- J. Each fire damper shall be held in the open position by a releasing device consisting of a fusible link and either a stranded wire or a steel strap. Alternatively the damper blade may be released by a fusible phial in a cartridge housing. The fusible element shall operate at 70°C.
- K. For dampers with blades out of the air , the resistance to air flow shall not exceed 5Pa. For the aerofoil blade pivot type, the resistance to air flow shall not exceed 5Pa.
- L. Fire dampers shall subject to the approval of authorities having jurisdiction.

## 2.03 ACCESS DOORS

- A. All access openings shall be rigidly framed, with airtight covers designed so that they can be speedily removed and refixed. Multiple set screws and self-tapping screws are not acceptable, as a method of fixing.
- B. Covers shall be pre-insulated "sandwiched" construction to match thermal/vapour seal performance of surrounding ductwork insulation.

- C. Subject to the restrictions imposed by duct dimensions, openings for access should not be smaller than 375 x 300mm or larger than 450 x 375mm, and openings for inspection should have a minimum diameter of 100mm.
- D. Where ducts are to be thermally insulated the frame of the access door or cover shall be extended beyond the face of the duct by a measurement equal to the thickness of the insulation and be so arranged that the insulation and finish can be "dressed" into the frame, thereby ensuring that the opening is not concealed and the edges of the insulation are protected from accidental damage.

#### 2.04 FLEXIBLE JOINTS

- A. The material for flexible joints shall have good acoustic absorption performance and shall satisfy the conditions of temperature, air pressure and fire resistance specified, and shall comply with the standard of airtightness specified for the rest of the ductwork system of which it forms part.
- B. Flexible joints shall be kept as short as practicable above a minimum effective length of 50mm. In no case shall the flexible joint exceed 250mm in length.
- C. The flexible materials flange shall be backed by an angle or flat iron flange and the flexible joint shall be securely held between the metal flanges.
- D. Flexible joints shall be made from, or protected by, material having a fire penetration time of at least fifteen minutes, when tested in accordance with BS 476, Part 8. The material shall be of the glass fibre cloth type.

#### 2.05 FLEXIBLE CONNECTIONS

- A. The flexible duct shall have a liner and a cover of tough tear-resistant fabric equal in durability and flexibility to glass fibre fabric and shall be impregnated and coated with plastic. It shall be reinforced with a bonded galvanised spring steel wire helix between the liner and the cover and an outer helix of glass fibre cord or equal shall be bonded to the cover to ensure regular convolutions.

Alternatively, the flexible duct shall consist of a flexible corrugated metal tubing of stainless steel, aluminium, tinplated steel or aluminium coated steel. The metal may be lined on the inside or the outside or both with plastic material.

- B. The frictional resistance to air flow per unit length of the flexible duct shall not exceed 50% more than the frictional resistance per unit length of galvanised steel ducts of equivalent diameter.
- C. The leakage from any section of flexible duct shall not exceed 1% of the design air flow rate at the static operating pressure.
- D. Flexible ducts shall be suitable for an operating temperature range of -18°C to 120°C and the pressure range of the system. Flexible duct shall comply with BS 476 Part 7 (Class 1 : Surface of very low flame spread).
- E. Flexible ducts of more than 0.5 metre length shall not be permitted.
- F. Flexible ducts shall be either pre-insulated at the works, or alternatively insulated as for circular supply ducts.

2.06 SEALANTS, GASKETS AND TAPES

- A. All materials including liquid and mastic sealants shall, when used in connection with ductwork jointing, permanently retain adhesion and elasticity through a temperature range of 0°C to 70°C and pressure range applicable to the system.
- B. Gaskets shall be of a pre-formed roll, sheet or strip. Gaskets shall not be less than 3mm thick for rectangular ducts up to 1500mm (longest side) or circular ducts up to 1250mm diameter. For larger ducts, the gaskets shall not be less than 4mm thick.

**PART 3 EXECUTION**

3.01 STORAGE

- A. All materials shall be stored on purpose made compartmented racks or shelving within a well lit storage container and suitably covered to prevent the ingress of dirt.
- B. Larger items shall be covered and stored clear of the ground in an area where they are not susceptible to damage.
- C. All items shall be separated by their tank size, laid out in an orderly fashion and clearly marked for ease of identification.

3.02 VOLUME CONTROL DAMPERS

- A. Dampers shall be installed in the positions shown on the Drawings and where branches or sub-branches leave the main distribution ducts. Sufficient dampers shall be provided to regulate and balance the systems.
- B. Dampers shall be positioned to enable full access to operating handles, and such that position indicators are clearly visible.
- C. Dampers shall be positioned in sufficient length of straight ductwork to enable access doors to be mounted adjacent to the damper.
- D. Dampers shall be installed as remote as possible from terminal devices and ductwork open ends, to prevent regenerated noise being transmitted to the occupied space.

3.03 FIRE/SMOKE DAMPERS

- A. Fire dampers shall be installed where indicated on the Drawings and in all positions where air passages or ducts pass through fire compartments and ceiling smoke barriers and at the termination point of fire-clad ductwork.
- B. In large section ducts where single units of sufficient size cannot be incorporated multi-section units shall be fitted.
- C. Fire dampers shall be installed to enable full access to linkages, and in such manner that position indicators are clearly visible.
- D. The Contractor shall include for the full testing of all fire damper and for resetting after testing.
- E. Fire dampers shall be installed strictly in accordance with the manufacturer's instructions, with particular attention to the maximum number and diameter of bends on solenoid operating cables.

3.04 ACCESS DOORS

- A. Access doors shall be installed in all positions indicated on the Drawings and where required to gain full access all duct mounted items.
- B. Access doors shall be installed adjacent to all fire dampers in such a manner that full access is available to both the damper and fusible link.
- C. Access doors shall be provided adjacent to all balancing dampers.
- D. Should adequate access not be achieved due to the physical restrictions of the duct size then one access door shall be positioned either side of the fire dampers or volume control damper.

3.05 FLEXIBLE JOINTS

- A. Flexible joints shall be fitted at inlet and outlet connections to all fans, fan coil units, ducted split units and package units, and where ducts cross building expansion joints. Any other required locations shall be indicated on the design drawings. Care should be taken to maintain alignment between the fan and the duct connection.
- B. With flanged rectangular connections the flexible material shall be held in place with flat bar strips attached to a mating flange. For spigot connections the flexible material shall be held in place with flat bar strips. Flat bar strips shall be used with proprietary flexible material having sheet metal attached along the edges. Flat bar strips shall be not less than 2 mm thick.
- C. Adaptors shall be used to provide plain circular ends for spirally-wound ducts. A sealant, in accordance with the requirements of the Specification, shall be used between the duct and the flexible joint and the joint secured by clip bands with adjustable screw or toggle fitting.

3.06 FLEXIBLE CONNECTIONS

- A. Flexible connections shall be installed as indicated on the Drawings and selected to suit the spigot size of the relevant duct or item of equipment.
- B. Flexible connections shall be secured to spigots with bandclips of a proprietary manufacture.
- C. The use of flexible duct between rigid sections of sheet metal ductwork to change direction or plane will not be permitted except where indicated or expressly authorised by the Engineer.
- D. Radius bends flexible duct shall not be permitted and sets shall be of such a nature that a reduction in the cross sectional area shall not occur.

3.07 SEALANTS, GASKETS AND TAPES

- A. The manufacturer's recommendations and precautions relating to use of sealants, gaskets and tapes shall be strictly complied with.
- B. Sealants, gaskets and tapes shall be applied to the mating surfaces of a joint and joint pulled together such that the form of sealing is under compression. Sealants applied over a joint shall not be permitted.
- C. Self-adhesive tape shall not be permitted as a primary sealant.

3.08 TEST HOLES

Where test holes are cut at works or drilled on site at time of commissioning, all holes shall be plugged, using effective removable plastic airtight sealing plugs. Samples of these plugs shall be approved by the Architect/Engineer.

END OF SECTION 15910

## SECTION 15940 AIR OUTLETS AND INLETS

### PART 1 GENERAL

#### 1.01 SCOPE OF SECTION

- A. This technical Specification establishes the type and quality of materials and the standard of workmanship to be used in the supply and installation of Air Outlets and Inlets or Air Terminal Devices.

#### 1.02 WORK INCLUDED

- A. The work includes the provision of all labour, materials and the performance of all operations in connection with the supply and installation of air terminal devices as specified herein and where referred to on the Drawings and Schedules.
- B. Coordination: The Contractor shall be responsible for the full coordination of the work of all trades.

#### 1.03 APPLICABLE CODES AND STANDARDS

- A. The air terminal devices and all associated materials and workmanship shall comply fully with the latest relevant British Standards and ISO Standards in all res.

The following are the most commonly used and relevant British Standards and ISO standards associated with air terminal devices and associated materials. However, the Contractor shall ensure that all applicable British Standards and ISO Standards are complied with whether listed here or not.

BS: 4773 : Methods for testing and rating air terminal devices for air distribution systems: Part 1, Aerodynamic testing.

ISO: 5219 : Air distribution and air diffusion: Laboratory aerodynamic testing and rating of air terminal devices.

- B. Applicable industry definitions - refer to schedules.

Given below are definitions of the basic terms to describe the characteristics of ATDs.

Core Area (*A<sub>c</sub>*) The gross area containing all the openings of the ATD.

Free area (*A*) This is the sum of the smallest areas of the cross-section of all the openings of an ATD.

Effective area (*A<sub>o</sub>*) This is the smallest area of an ATD through which air passes and which may not be equal to its free area. It is given by:

$$A_o = Cd A$$

where *A* is the free area and *Cd* is discharge coefficient which usually varies between 0.65 and 0.9.

Free area ratio (*R<sub>a</sub>*) This is the ratio of free area to core area.

Envelope This is a surface of the jet produced by a supply ATD which has the same velocity, usually taken to be 0.25 or 0.5 m/s

Throw (*X<sub>m</sub>*) The maximum distance between the plane of a supply ATD and a plane which is tangential to the jet envelope and perpendicular to the initial jet direction.

Drop or rise (*Y<sub>m</sub>*) The vertical distance between the centre of a supply core and a horizontal plane tangential to the envelope.

Spread ( $Z_m$ ) The maximum horizontal distance between two vertical planes tangento the envelope of a supply ATD and perpendicular to a plane through the core axis.

Core velocity ( $U_c$ ) The volume of air flow rate divided by the core area of the ATD.

Discharge velocity ( $U_o$ ) The average velocity at the discharge from an opening of an ATD which is equal to  $U_c/(CdRa)$ .

1.04 SUBMITTALS

- A. Drawings refer to 15010
- B. Report on works test as described in 15930 Part 2.
- C. Manufacturers data for each type of ATD including confirmed noise and performance details.

1.05 OPERATION AND MAINTENANCE DATA

- A. Comply with 15010

1.06 WARRANTY

- A. Provide 12 months warranty in accordance with contract conditions.

**PART 2 PRODUCTS.**

2.01 GRILLES

- A. Grilles shall be of aluminum extrusion of the types and sizes indicated on the drawings and in the schedules and be of the concealed fixing type. Where the size is not indicated, the grilles shall be selected for the air volume flow rates indicated in the schedules to achieve the required throw, and be within the relevant noise level for the area being served.
- B. All grilles shall be provided with an aluminum opposed blade multi leaf damper, with loose key to allow adjustment of the concealed adjuster from the face of the grille. One loose key for every 20 grilles shall be provided.
- C. Each supply grille shall have two sets of individually adjustable aluminum blades, one set horizontal the other vertical.
- D. Extract grilles shall be as indicated on the drawings, and in the schedules. Where the grilles does not have to be matched to the supply grille, it shall be of the eggcrate type.
- E. For kitchens and dining rooms grilles shall have quick release subframes.
- F. Non vision grilles be as indicated on the drawings and shall be of the inverted chevron type comprising a non-vision insert core held firmly between two mating flanged frames. In the case of door mounted applications these shall be rattleproof, provided with screw fixings and telescopic aluminum frames.
- G. All grilles shall be supplied with a stove enamel paint finish to a BS RAL colour.

2.02 DIFFUSERS

- A. Air diffusers shall be supplied and installed in accordance with the duties, sizes and locations shown on the drawings.

- B. Square diffusers for supply air shall be manufactured from extruded aluminum and shall be supplied complete with opposed blade volume control dampers. Both dampers and grilles shall have concealed screw type fixings. Spring clip fixings shall not be permitted.
- C. Where a supply diffuser is directly connected to a stub duct which has a straight of less than two diameters or equivalent diameters, then an equalizing grid or deflector shall be used.
- D. The frames of all diffusers shall be provided with positive seals with the exception of those mounted on exposed ductwork. Frames shall be of a type compatible with the ceiling type or wall finish.
- E. All diffusers shall be supplied with a stove enamel paint finish to a BS RAL colour as approved by the Architect.
- F. All diffusers shall be provided with galvanized steel plenum boxes, lined with acoustic insulation. The plenums shall be sized to match the diffuser and be complete with fixing lugs and incorporate an opposed blade central damper adjustable from the diffuser face and it shall be sized to restrict the re-generated noise level.
- G. The schedules provided indicate volume flows, throws, maximum noise levels and the Contractor shall ensure that the grille and diffuser manufacturer shall assess the data and confirm that his selections comply with the stated parameters.

### 2.03 LOUVRES

- A. Air intakes and discharges associated with package units and fan convectors shall consist of ducted connections made to flanged openings formed in the galvanized sheet steel blanking plates fixed to the rear of the building weather louvres. The blanking plates shall be used to cover over un-used areas of the weather louvres, and shall be provided under Division 15.
- B. Sand trap louvres shall be incorporated into the airtake ductwork sections where indicated.
- C. The sand collection efficiency of the sand trap at a face velocity of 0.6 m/s shall not be less than 80% with a sand consistency of 92% of particles falling within the 150 to 425 microns range. The pressure loss shall not exceed 30 Pa. Intakes shall be provided with air filters with minimum efficiency of 70%.
- D. Louvres not forming part of the building cladding are scheduled in Division 15.

## PART 3 EXECUTION

### 3.01 STORAGE

- A. All air terminal devices shall be stored within a well lit container on purpose made shelving. The devices shall be stored in their original packaging to prevent damage to the finish.



3.02 GENERAL INSTALLATION

- A. The air terminal devices shall be identified by reference number as to their final location. Plenum boxes shall be similarly numbered to reduce the risk of incorrect matching.
- B. Grilles, diffusers and plenum boxes shall be supported independently from the building structure unless otherwise instructed by the Engineer. Grilles diffusers and plenums shall not be supported from the ceiling grid.
- C. All volume control dampers shall be left in the fully open position.
- D. Diffusers shall be securely fixed to plenum boxes by means of concealed adjustable mounting brackets.
- E. During construction the Contractor shall ensure that the location and fixing of all grilles and diffusers is fully coordinated between the relevant trades.

END OF SECTION 15940

## SECTION 15996

### HVAC TESTING, ADJUSTING, AND BALANCING

#### PART 1 GENERAL

##### 1.01 SCOPE OF SECTION

- A. This Technical Specification establishes the type and quality of materials and the standard workmanship to be used in the testing, adjusting and balancing of all of the Heating, Ventilation and Air Conditioning System.

##### 1.02 WORK INCLUDED

- A. The work includes the provision of all labour, materials and the performance of all operations in connection with the testing, adjusting and balancing as specified herein and where referred to on the Drawings.
- B. Coordination: The Contractor shall be responsible for the full coordination of the work of all trades.
- C. The Contractor shall ensure that electricity, water and other necessary services are available to test and commission the completed installation. The Contractor shall allow for utilising temporary supplies if permanent supplies are not available.

##### 1.03 QUALITY ASSURANCE

- A. Contractor shall submit the curriculum vitae of staff who are regularly engaged and are qualified in the testing, adjusting, and balancing of mechanical engineering services and who have at least 5 years successful experience on projects of a similar nature. The Engineer's decision for acceptance or rejection of proposed staff shall be final.

##### 1.04 APPLICABLE CODES AND STANDARDS

- A. The testing, adjusting, and balancing and all associated materials and workmanship shall comply fully with the latest relevant British Standards and other standards in all resp.

The following are the most commonly used and relevant Standards associated with testing, adjusting and balancing and associated materials. However, the Contractor shall ensure that all applicable Standards are complied with whether listed here or not.

CIBSE	-	Commissioning Codes A, C, R and W
ASHRAE	-	1987 HVAC Systems and Applications Handbook Chapter 57
BSRIA	-	Precommission cleaning of water systems.
	-	Commissioning of water systems in buildings.

##### 1.05 SUBMITTALS

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- A. Commissioning and testing procedures manual at least 4 weeks prior to pre-commissioning starts.
- B. Test data as described and as required by CIBSE commissioning codes A,C,R and W.

### 1.06 OPERATION AND MAINTENANCE DATA

- A. Comply with 15010
- B. Full commissioning and testing report.

### 1.07 WARRANTY

- A. Provide 12 months warranty in accordance with contract conditions.

## **PART 2 PRODUCTS**

- A. The Contractor shall provide at least the following instruments for his staff to satisfactorily test adjust and balance the works. Each instrument shall have a current manufacturers test and calibration certificate:-

1. (i) 1 No. electronic thermometer range 0°C to 120°C complete with the following:-
  - (ii) 1 No. duct probe
  - (iii) 2 No. insertion type pressure/temperature probes
2. 1 No. electronic anemometer
3. 2 No. mechanical anemometer
4. 1 No. air flow box complete with 450 mm, 900 mm and 1500 mm Pitot static tubes
5. 1 No. smoke puffer and smoke pellets set
6. 1 No. sling psychrometer
7. 1 No. amprobe
8. 1 No. avometer
9. 1 No. tacometer rocking type
10. 1 No. mercury manometer 1.2 m long, complete with bypass valve, isolating valves, 2 No. 4 m lengths or PVC tube fitted for receiving pressure sensing insertion needle all to be contained within a purpose-made case.
11. 1 No. direct reading air volume measuring hood registering m<sup>3</sup>/s and complete with a range of interchangeable hood to suit all grille and diffuser types.

- B. The Contractor shall prepare standardised data recording sheets for all the tests, for approval by the Engineer.
- C. The standard forms shall cross reference the works being tested with the appropriate drawings and specification clauses. The forms shall also show for each measured

value, the original design value, the site measured, the difference and the allowable design value tolerance.

### **PART 3 EXECUTION**

#### **3.01 GENERAL**

- A. Access shall be afforded at all times to the Engineer to enable him to inspect the mechanical equipment.
- B. Upon completion of the mechanical services installation or part of the installation, the Contractor shall carry out and be responsible for testing and commissioning it, in stages if required, to ensure that it is in proper working order and capable of performing all of its functions in accordance with the Specification and to the satisfaction of the Engineer. Mechanical equipment damaged during testing, adjusting, and balancing shall be replaced and retested by the Contractor at his own expense to the satisfaction of the Engineer.
- C. All testing shall be carried out according to the requirements of the relevant standards and regulations as may be stated or implied in the Specification or otherwise agreed by the Engineer in writing.
- D. The Contractor shall submit, no later than 6 weeks prior to the commencement of testing and commissioning, a schedule of all mechanical equipment tests and commissioning procedures that he intends to carry out to prove that the mechanical equipment complies with the requirements of the Specification together with his proposed programme for such tests and commissioning.
- E. Tests shall not commence before the schedule of tests has been approved and such other tests as may be required by the Engineer shall be included within the schedule of tests.
- F. The Contractor shall give to the Engineer in writing at least ten days' notice of the date by which he will be ready to make the specified tests on completion of installation. Unless otherwise agreed the tests shall take place within seven days after the said date on such day or days as the Engineer shall in writing notify the Contractor.
- G. The tests shall as far as possible be carried out under normal working conditions to the satisfaction of the Engineer and shall extend over such periods as he may direct.
- H. The Contractor shall provide all skilled labour, supervision, apparatus and instruments required for commissioning and testing and within a reasonable time thereafter furnish to the Engineer a total of six certificates of all tests performed and accepted, signed by the Contractor, or an authorized person acting on his behalf.
- J. If the tests fail to demonstrate the satisfactory performance of the installation thereof then the Engineer shall decide whether such failure is due to incorrect, inadequate or defective materials. If this be so, then the Contractor shall, at his own expense, carry out such alterations or replacements as are required to the Engineer's complete satisfaction. The Engineer shall be at liberty to call for a further test when such alterations have been made and his decision as to what constitutes a satisfactory test shall be final.

- K. The foregoing general requirements as to testing shall be read in conjunction with any particular requirements specified elsewhere.
- L. Work which is to be concealed or buried shall be inspected and tested in the presence of the Engineer before any permanent covering shall be applied. The Contractor shall give due notice in writing to the Engineer when the said concealed or buried work is ready for inspection and the Engineer shall, without unreasonable delay, carry out his inspection and/or witness the tests unless he considers such inspection unnecessary, but in no instance shall concealed or buried work be covered without being tested by the Contractor in the manner described in the Specification.
- M. In the event of the work being concealed or buried prior to the inspection and testing to the reasonable satisfaction of the Engineer, then the Engineer shall be empowered to have the work revealed and tested. All costs in connection with this requirement shall be borne by the Contractor in the event of the tests not being satisfactory.
- N. In cases where the overall building programme is such that the Contractor shall need for the purpose of testing, regulation, adjustment, etc., to test portions of the building which by that time may be occupied by the Client, the Contractor shall allow in his tender accordingly and shall take all necessary precautions against damage when working in such areas.
- O. Acceptance by the Engineer of any part of the works shall not in any way absolve the Contractor of his responsibility for the performance of the mechanical equipment after the completion of the Testing, Adjusting, and Balancing.
- P. Each completed system within the installation shall be tested as a whole under normal site operating conditions to ensure that each component functions correctly in conjunction with the rest of the system.

### 3.02 TEST REQUIREMENTS

- A. All tests shall be carried out in the presence of the Engineer.
- B. Notwithstanding any information in the Section, the testing requirements shall be endorsed by the specific requirements set out in each section of the Specification for specialist installations, and to the particular performance standards therein.

### 3.03 PLANT AND EQUIPMENT TESTING

- A. For manufactured plant and equipment, tests shall be carried out, either to the relevant BSS or to the requirements of this Specification (should the latter requirements be in excess of the relevant BSS) or the satisfaction of the Engineer. Triplicate certified certificates of all such tests shall be provided to the Engineer.

### 3.04 DUCTWORK TESTING

- A. The leakage testing of ductwork operating within the medium and high pressure classified range shall be carried out as outlined in SMACNA.
- B. It shall be noted that all medium and high pressure ductwork shall be tested for leakage prior to the application of insulation and the results presented on air leakage test sheets.
- C. Acceptable leakage rates shall be as defined in SMACNA.
- D. The Format of the air leakage test sheet shall be as the specimen given in SMACNA.

- E. Testing procedures shall be as defined above and generally in accordance with SMACNA.

### 3.05 GENERAL

In the event of the plant or any section or sections of the installation not passing these prescribed tests, the Contractor shall remedy all faults, and the plant, section or sections of the contract works shall be re-tested to the satisfaction of the Engineer. If the faults are not rectified to the Engineer's satisfaction, the Engineer may exercise the right to demand removal of that particular part of the installation.

### 3.06 ELECTRICAL SERVICES WORKS ASSOCIATED WITH HVAC

- A. Inspection and testing shall be carried out during installation and after completion of the works, and as described in 15171 and Division 16.
- B. Tests shall be carried out on site after completion to ascertain the insulation resistance of the conductors, cables and accessories and fittings to earth and between poles, the electrical continuity of metal sheaths surrounding conductors, and the polarities of all accessories and fittings, complying with the regulations specified in IEE Wiring Regulations 16th Edition with amendments ruling at date of tender.
- C. All tests be made in the presence of the Engineer who shall have been duly notified of the Contractor's intentions. The Engineer will require triplicate copies of test certificates covering all tests carried out on the completed installation.

### 3.07 COMMISSIONING

- A. Based on the design data specified in drawings, schedules and other information made available during the contract, the Contractor shall put into commission all installations and regulate in accordance with the agreed programme, adjust and balance where necessary and demonstrate to the Engineer that each section of all services is performing the duty for which it has been designed.  
A full comprehensive and complete commissioning report including test certificates and records shall be issued by the Contractor upon satisfactory commissioning of all systems. The installation shall be accepted for handover unless the commissioning manual has been submitted in a form acceptable to the Engineer.

Commissioning of the various services shall be carried out strictly in accordance with the U.K.CIBSE current Commissioning Codes or NEBB Procedures:

Series A - Air Distribution Systems - High and Low Velocity

Series C - Automatic Control Systems

Series R - Refrigeration Systems

Series W - Water Distribution Systems

- C. The Contractors procedures shall include the following:
  1. Test all equipment in accordance with manufacturers recommendations, checking rotation, revs, running current on each phase of electrical motors.
  2. Run HVAC systems with air filters to disperse all dust, etc., and commission the system before the introduction of the Client's filters.
  3. Measure air volumes, and pressures across fans. Proportionally balance air systems.

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4. Check airside and waterside pressure drops across all items of equipment and all individual air handler sections.
  5. Measure air on/off, temperatures to all cooler coils, heat exchanger, evaporators package.
  6. Demonstrate to the Engineer the start-up, control, and shut down of each package units including the operation of safety devices. The Contractor shall allow for the manufacturers engineer to be presented on site to pre-commission, commission, test and demonstrate the chillers in accordance with a programme approved by the Engineer.
- D. The Contractor will be required to demonstrate every function and interlock relating to the automatic controls. This demonstration shall be conducted under simulated occupancy and shall include but not limited to:
1. All automatic temperature control functions in high limit and safety cutouts.
  2. All start-up and shut-down functions including those instigated by timers, manually and by emergency and fire alarm signals.
  3. The operation and re-setting of smoke fans and dampers.
- E. Air circulation and distribution shall be demonstrated after the systems have been balanced by the Contractor to provide the design air quantities. Pitot tube readings shall be taken in all ductwork mains and branches together with terminal point readings. Smoke tests may be required to prove distribution within enclosures and these shall be at the Engineer's discretion.
- F. At the completion of the Contractor's commissioning and prior to any final approval from the Engineer, simultaneous internal and external dry and wet bulb temperatures shall be taken, witnessed and recorded. Should the contract programme determine that such temperature recording tests occur during partial load conditions then the Contractor will be required to return to site and repeat the tests when design external conditions apply.
- G. As part of the commissioning process, the Contractor shall arrange for all necessary checks and witnessing by the Municipality Authority, Government Offices, Statutory Authorities, etc. necessary for the handing over and occupation of the building.

The Contractor shall be prepared to carry out similar tests at the end of the Defects Liability Period if the Engineer deems it necessary to prove that the plant and installation are still functioning in accordance with the requirements of the Specification. The Contractor shall allow for this item at the time of tender.

END OF SECTION 15996

# **ELECTRICAL WORKS**



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**ELECTRICAL**  
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**SECTION 14010**  
**ELECTRICAL GENERAL PROVISIONS**

**PART 1 - GENERAL**

**1.01 SUMMARY**

Provide labor, materials and equipment required to complete and functioning electrical systems as required by the contract documents.

The work includes, but is not limited to, the following principal systems and equipment:

1. 400/230 volt distribution.
2. Panel boards.
3. 600V Cables.
4. 450/750V Wiring.
5. Lighting fixtures, poles, lamps and ballasts.
6. Wiring Accessories.
7. Voice & Data system
8. Earthing system.
9. Fire alarm

**1.02 APPLICABLE PROVISIONS**

- I. Application. Provisions of this section apply to every section of Division 16 - Electrical, except where specifically modified.

**1.03 RELATED WORK**

- I. Site Work.
- II. Concrete.
- III. Doors and Windows.
- IV. Painting.
- V. Equipment.
- VI. Mechanical equipment.

**1.04 REFERENCE CODES AND STANDARDS**

Standards of the following organizations may be referenced in the specification. Unless noted otherwise, references are to standards or codes current at the time of bidding.

- I. Jordanian codes
- II. Local Utilities regulations
- III. British standards (BS).

- IV. IEE wiring regulations, 16th edition, BS 7671:2001
- V. Code of Interior Lighting issued by the Chartered Institution of building services of UK (CIBSE).
- VI. Fire Alarm Regulations issued by National Fire Protection Association (NFPA).
- VII. Electrical Installation of Buildings, IEC-364 publication.

#### **1.05 REGULATIONS AND PERMITS**

I. **Regulations.** Work, materials and equipment must comply with the latest rules and regulations of the following:

- 1- Local Utilities regulations
- 2- British Code (BS)
- 3- International Electro technical Commission (IEC).

II. **Discrepancies.** The drawings and specifications are intended to comply with listed codes, ordinances, regulations and standards. Where discrepancies occur, immediately notify the Owner's representative in writing and ask for an interpretation. Should installed materials or workmanship fail to comply, the Contractor is responsible for correcting the improper installation. Additionally, where sizes, capacities, or other such features are required in excess of minimum code or standards requirements, provide those specified or shown.

**Permits.** Obtain certificates of inspection and other permits required as a part of the work.

#### **1.06 CONTRACT DRAWINGS**

I. **Intent.** The intent of the drawings is to establish the types of systems and functions, but not to set forth each item essential to the functioning of the system. Electrical drawings are generally diagrammatic and show approximate location and extent of work. Install the work complete, including minor details necessary to perform the function indicated. In case of doubt as to work intended, or if amplification or clarification is needed, request instructions from the Owner's representative.

II. **Discrepancies.** Review pertinent drawings and adjust the work to conditions shown. Where discrepancies occur between drawings, specifications, and actual field conditions, immediately notify the Owner's representative for his interpretation.

III. **Outlet and Equipment Locations.** Coordinate the actual locations of electrical outlets and equipment with building features and equipment as indicated on architectural, structural, mechanical and plumbing drawings. Review with the Owner's representative any proposed changes in outlet or equipment location. Relocation of outlets before installation, of up to 2 meters from the position indicated, may be directed without additional cost. Remove and relocate outlets placed in an unsuitable location, when so requested by the Owner's representative.

## 1.07 CONTRACTOR QUALIFICATIONS

An acceptable Contractor for the work under this division must have personnel with experience, training and skill to provide a practical working system. The Contractor will be required to furnish acceptable evidence of having installed not less than three systems of size and type comparable to this project. The systems must have served satisfactorily for not less than 2 year.

## PART 2 - PRODUCTS

### 2.01 PRODUCT REQUIREMENTS

- I. **Condition.** Provide new products of manufacturers regularly engaged in production of such equipment. Provide the manufacturer's latest standard design for the type of product specified.
- II. **IEC & BS.** Products must conform to requirements of the International Electro technical Commission and British Standards.
- III. **Space Limitations.** Equipment selected must conform to the building features and must be coordinated with them. Do not provide equipment which will not suit arrangement and space limitations.
- IV. **Factory Finish.** Equipment must be delivered with a hard surface, factory-applied finish so that no additional field painting is required except for touch-up as required.

## PART 3 - EXECUTION

### 3.01 PROTECTION OF EQUIPMENT

- I. **Moisture.** During construction, protect switchgear, transformers, motors, control equipment, and other items from insulation moisture absorption and metallic component corrosion by appropriate use of strip heaters, lamps or other suitable means. Apply protection immediately on receiving the products and maintain continually.
- II. **Clean.** Keep products clean by elevating above ground or floor and by using suitable coverings.
- III. **Damage.** Take such precautions as are necessary to protect apparatus and materials from damage. Failure to protect materials is sufficient cause for rejection of the apparatus or material in question.
- IV. **Finish.** Protect factory finish from damage during construction operations and until acceptance of the project. Satisfactorily restore any finishes that become stained or damaged.

### 3.02 INSTALLATION

- I. **Cooperation with Other Trades.** Cooperation with trades of adjacent, related or affected materials or operations, and of trades performing continuations of this work under subsequent contracts, is considered a part of this work in order to effect timely and accurate placing of work and to bring together, in proper and correct sequence, the work of such trades.

II. **Workmanship.** Workmen skilled in their trade must perform work. The installation must be complete.

III. **Setting of Equipment.** Equipment must be leveled and set plumb. Sheet metal enclosures mounted against a wall must be separated from the wall not less than 20 mm by means of corrosion-resistant spacers or by 10 cm of air for freestanding units. Use corrosion-resistant bolts, nuts and washers to anchor equipment. In sufficient time to be coordinated with work under other divisions, provide drawings and layout work showing exact size and location of sleeves, openings or inserts for electrical equipment in slabs, walls, partitions and chases.

IV. **Sealing of Equipment.** Seal openings into equipment to prevent entrance of animals, birds and insects.

V. **Motors.**

1- Electrical work includes the electrical connection of all motors, except those, which are wired as a part of equipment.

VI. **Concealed Work.** Conceal all electrical work in walls, floors, chases, under floors, underground and above ceilings except:

- 1- Where shown or specified to be exposed. Exposed is understood to mean open to view.
- 2- Where exposure is necessary to the proper function.
- 3- Where size of materials and equipment preclude concealment.

VII. **Application.** Unless otherwise indicated, power will be utilized as follows:

- 1- 400 volts, three phase: motors 3 horsepower and larger.
- 2- 230 volts, single phase: motors 2 horsepower and smaller.
- 3- 230 volts, single phase: incandescent, fluorescent and high-intensity-discharge lighting.
- 4- 230 volts, single phase: convenience outlets.
- 5- 230 volts, single phase: special power and equipment.
- 6- 400 volts, three phase: special power and equipment.

### 3.03 EQUIPMENT AND DEVICE MARKING

I. **Designations.** Identify all equipment, devices, feeders, branch circuits and similar items with the same designations as indicated on the contract documents.

II. **Nameplates.** Externally mark all electrical equipment with nameplates identifying each and the equipment served. Nameplates shall be black laminated rigid phenolic with white core. Nameplate minimum size shall be 30mm high by 75 mm long with 5 mm high engraved white letters. Supply blank nameplates for spare units and spaces.

III. **Nameplate Fasteners.** Fasten nameplates to the front of equipment only by means of stainless steel self-taping screws. Stick-on or adhesives will not be allowed unless.

IV. **Nameplate Information.** In general, the following information is to be provided for the types of electrical equipment as listed.

- 1- Switchboards and Motor Control Centers. On the mains identify the piece of equipment, the source and voltage characteristics (i.e., 400/230V, 3PH 4W). For each branch circuit protective device, identify the load served.

- 2- Individual Starters, Contactors, Disconnect Switches, Transfer Switches and similar equipment. Identify the device designation, source and load served.
  - 3- Panel boards. Identify the source, panel board designation and voltage characteristics.
- V. **Panel boards.** Prepare a neatly typed circuit directory behind clear heat-resistant plastic in a metal frame attached to the inside of the door for each panel board. Identify circuits by equipment served and by room numbers where room numbers exist. Indicate spares and spaces with light, erasable pencil marking. Adhesive mounted directory pocket is not acceptable.
- VI. **Pull, Junction and Outlet Boxes.** With 15 mm high lettering, identify conduits connected to pull, junction and outlet boxes with the complete circuit number of the conductors contained therein. Where multiple circuits are contained in a box, identify the circuit conductors with permanent tags, which indicate circuit designation.
- VII. **Equipment and Raceways Over 600 Volts.** Provide "WARNING - HIGH VOLTAGE - KEEP OUT" signs on all equipment. With 50 mm high lettering, mark all exposed raceways containing conductors operating in excess of 600 volts every 30 meters with the words "WARNING - HIGH VOLTAGE."
- VIII. **Power Socket Outlets.** Use nameplate or engrave device plate to identify power socket outlets where the nominal voltage between any pair of contacts is greater than 230 volts with circuit number, voltage and phases. If nameplates are used, attach to wall directly above device plate.
- IX. **Wall Switches.** Where the equipment served is not in sight of the wall switch, provide an engraved switch plate or attach a nameplate to the wall directly above the switch.

### 3.04 TESTING

- I. **Test Conditions.** Place circuits and equipment into service under normal conditions, collectively and separately, as may be necessary to determine satisfactory operation. Perform specified tests in the presence of the Owner's representative. Furnish all instruments, wiring, equipment and personnel required for conducting tests. Demonstrate that the equipment operates in accordance with requirements of the drawings and specifications.
- II. **Test Dates.** Schedule final acceptance tests sufficiently in advance of the contract date to permit completion of any necessary adjustment or alterations within the number of days allotted for completion of the contract.

END OF SECTION

**SECTION 14020  
ELECTRICAL SERVICES**

**PART 1 - GENERAL**

**1.01 SUMMARY**

This section pertains to making arrangements for electrical services.

**1.02 REFERENCE STANDARDS**

- I. Comply with all service installation standards of the serving utility.

**PART 2 - ELECTRICAL SERVICE REQUIREMENTS**

**2.01 SOURCE**

- I. Electrical service will be provided from local power company system (Electrical distribution Company "EDCO"). The source characteristics are 400/230 volts, 3 phase, 4 wire, 50 hertz. Service to the project will be run via substation transformers located in substation room.

**2.02 COORDINATION**

- I. The location of the service entrance, power substation dimensions, floor trenches, transformers and switchgear pads must be coordinated with the local power company. Provide materials and equipment required to connect the project service to the utility system.

**PART 3 - EXECUTION**

**3.01 GENERAL**

- I. Install the utility services as required by local power company and the contract documents. Demonstrate that the electrical system is operational.

**END OF SECTION**

**SECTION 14060**  
**EARTHING**

**PART 1 - GENERAL**

**1.01 SUMMARY**

This section specifies the furnishing and installation of Earthing and equipotential bonding systems.

**1.02 REFERENCE STANDARDS**

- I. Jordanian codes
- II. Local Utilities regulations
- III. IEC-364-5-54
- IV. BS 7430, BS951

**PART 2 - PRODUCTS**

**2.01 EARTH RODS**

- I. Materials. Provide :- 25mm by 1750mm long, copper-clad, steel grounding electrodes. Supply a rod to which the copper cladding is permanently and inseparably bonded to a high strength steel core.

**2.02 CONNECTIONS**

- I. Materials. Unless otherwise noted, for below grade connections provide exothermic welded type. For above grade connections provide copper or bronze lugs or clamps. Where required, provide plated connectors which will not cause electrolytic action between the conductor and the connector.

**2.03 WIRING**

- I. Materials. Provide bare conductors for bonding jumpers. Provide 600-volt insulated conductors having a green/yellow-colored insulation for earthing electrode and equipment earthing conductors.

**2.04 EARTH BUS**

- I. Where a field-provided earth bus is required, use round-edge copper bar with 98 percent International Annealed Copper Standard (IACS) conductivity. Size the bus for not less than 25 percent of the cross-sectional area of the related feeder. A minimum size of 6 mm by 50 mm is required.



## PART 3 - EXECUTION

### 3.01 SYSTEM GROUND

- I. **Separately Derived Systems.** Ground neutrals of separately derived systems such as generators, telephone systems, etc., in accordance with the manufacturer recommendations.
- II. **Size.** Size the system grounding electrode conductors to comply with BS7430, unless shown larger.
- III. **Testing.** Test the completed grounding system. If the resistance of the grounding system is more than 2 ohms, add ground rods to attain 2 ohms.
- IV. **Overall Resistance:** the overall resistance for power system must be less than 2 ohms, where for data system and low current shall be less than 1 ohm.

### 3.02 EQUIPMENT GROUND

- I. **Switchgear Rooms.** Provide a 50 mm<sup>2</sup> bare stranded copper Earth bus in switchgear room. Mount bus 30 cm above finished floor and 25 mm from wall around perimeter of room. Connect bus by a grounding conductor with a cross-sectional area equivalent to the ground bus to an acceptable grounding electrode as described in BS7430. Connect all noncurrent-carrying metallic parts of electrical equipment in the room to the bus.
- II. **Raceway Systems and Equipment Enclosures.**
  - 1- Ground cabinets, junction boxes, outlet boxes, motors, controllers, raceways, fittings, switchgear, other electrical equipment and metallic enclosures. Ground equipment and enclosures to the continuous-grounded, metallic raceway system in addition to any other specific grounding shown.
  - 2- Provide bonding jumpers and earth wire throughout to ensure electrical continuity of the grounding system.
  - 3- Provide grounding-type insulated bushings for metal conduits 40 mm and larger terminating in equipment enclosures containing a ground bus and connect the bushing to the ground bus.
  - 4- Provide a green/yellow insulated equipment earthing conductor for each feeder and branch circuit.
- III. **Size.** When earthing and bonding conductors are not sized on drawings, size the grounding conductors in accordance with BS7430. Size bonding jumper so that minimum cross-sectional area is greater than or equal to that of the equivalent earthing conductor as determined from BS7430.

END OF SECTION

**SECTION 14100**  
**WIRING**

**PART 1 - GENERAL**

**1.1 WORK INCLUDED**

- I. Single core and multi core 450/750 volt wiring.
- II. Fixture Wiring
- III. Data network wiring
- IV. Low current systems and Signaling Systems Wiring
- V. Power Distribution wiring

**1.2 RELATED WORK**

- I. Equipment Identification Section
- II. Grounding and Bonding Section

**1.3 REFERENCE STANDARDS**

- I. Jordanian codes
- II. Local Utilities regulations
- III. BS 6094, 6004, 6346 and BS 6231
- IV. IEC 227, 287, 502, 540

**1.4 SUBMITTALS**

- I. Submit product data and manufacturers literature
- II. Submit blank commissioning test sheets
- III. Submit proposals for color coding of insulation
- IV. Submit completed test sheets.

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

- I. Building Wiring( lighting and power outlets) :

Rated voltage  $U_0/U = 450/750$  volts

Permissible operating temperature at conductor: 70 C

Power and Control wiring: Concentric lay, uncoated copper with a normal maximum operating temperature of 70 degrees C. Insulation to be 600 V PVC with black PVC jacket. Provide white conductor insulation with indelible black numerals at 25mm intervals on control cables. Maximum conductor size to be 10 mm<sup>2</sup>.

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- II. Flame Retardant Power and control Wiring: Multi Strand, concentric lay, coated copper with a normal maximum operating temperature of 90 degrees C and 600V flame retardant cross linked polyethylene insulation and overall cable jackets of chlorosulfonated polyethylene, all in accordance with Standards and Codes. Cable jacket to be applied over tape wrapped cable cores.
- III. Flame Retardant Alarm and instrument Cable : Multi strand, concentric lay, coated copper with a normal maximum operating temperature of 90 degrees C and 600V flame retardant cross linked polyethylene insulation, cable assembly shield of combination aluminum/Mylar tape and 7 strand 0.6 mm<sup>2</sup> minimum coated copper drain wire applied to achieve 100% cover over insulated conductors and chlorosulfonated polyethylene cable jacket. Twisted pair cables with 60 mm to 90 mm lay staggered. Each pair to be numbered.
- IV. Fixture Wire : Standard round coated copper with a operating temperature of 200 degrees C with 600V silicone rubber insulated and braided glass jacket, all in accordance with Standards and Codes.
- V. Telephone Cable : Single or multi-pair as required. Bare copper wire minimum 0.6mm diameter, 0.2mm thick PVC insulation, wires twisted to pairs with a cable core wrapping of insulating foil, additional 0.4mm diameter (up to 10 pairs) or 0.6mm diameter (above 10 pairs) ground wire, with aluminum foil wrapping, insulating foil wrapping and PVC cable assembly jacket. All telephone installations shall conform to Local Telecommunication Corporation Regulations and Approvals.
- VI. Fire alarm Signal Cable: shall be fire resistant multi-core cable to conform with civil defense regulations and manufacturer recommendations.
- VII. Loudspeaker Cable : Single pair with solid copper conductor (1.25mm diameter) in flat configuration with polyethene insulation and PVC jacket. Conductors to have a maximum DC loop resistance at 20 degrees C of 28 ohms per kilometer and a nominal capacitance of 91 Pico farads per meter.
- VIII. Control cable: Multi core 2.5 mm<sup>2</sup> cable as described in part 2.1I above.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- I. Ensure conductor lengths for parallel feeders are equal.
- II. Lace or clip conductor groups at switch gear panels, pull boxes, wire ways, etc.
- III. Provide grounding conductors and straps in accordance with other sections.
- IV. Wiring in conduit only to be installed after concrete, masonry and plastering work is Complete and all conduits have been cleaned out and dried.
- V. Splice cables at accessible junction or outlet boxes only.
- VI. Color code all wiring insulation as per other sections.
- VII. Terminate cables in accordance with the manufacturers recommendations.
  
- VIII. Color codes : 230V System  
Phases : Red, yellow, blue

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Neutral:       Black

Ground        : Green/yellow in combination or green

### **3.2 TESTS**

- I.     All power circuits shall be tested with the circuit complete except for connections to equipment.
- II.    Test all wiring for continuity, polarity and insulation resistance after installation and before connection.
- III.   Test fiber cables for continuity, loss and bandwidth.
- IV.   Test UTP cables for continuity, loss, resistance and length.

END OF SECTION

**SECTION 14110  
CONDUITS**

**PART 1 - GENERAL**

**1.01 SUMMARY**

This section specifies the furnishing and installation of electrical Conduits.

**1.02 REFERENCE STANDARDS**

- I. Jordanian codes
- II. Local Utilities regulations
- III. IEC-614-2-5: Part 2 and BS 731- Flexible Metal Conduit.
- IV. BS4607, BS 6053 and BS 6099 For PVC conduits and fittings.
- V. BS4568, BS 6053 and VDE 0605 Rigid Metal Conduit.

**1.03 SUBMITTALS**

The contractor must submit catalogues and samples for the engineer approval.

**PART 2 – PRODUCTS**

**General**

The Contractor shall supply and install a complete conduit system as shown on the Drawings and as herein specified. The system shall include conduits, fittings (couplings, bends, boxes, cover plates, reducers, adaptors, etc.) and all necessary parts to install a complete conduit system.

Conduits and fittings shall be distinctively marked as manufactured for electrical purposes.

Conduit runs are shown diagrammatically to outline the general routing of the system. The installation shall be made to avoid interfering with pipes, ducts, structural members, or other equipment. Should structural or other interferences prevent the installation of the conduits, or setting of boxes, cabinets, or other electrical equipment, as indicated on the Drawings, deviations must be approved by the Engineer, and after approval, shall be made without additional charges. The number of conduits shall not be less than that indicated on the Drawings.

Conduits and conduit fittings shall be so designed and constructed that they ensure reliable mechanical protection to the cables contained therein, and shall withstand the stresses likely to occur during transport, storage and installation. They shall be marked with the marker's name or trade mark. Marking shall be indelible and easily legible.

Conduits shall have a minimum 20 mm (outer diameter) size and shall be adequate for proper and easy wire pulls, and in no case shall the wires occupy a cross-sectional area of more than 30% of the inner conduit cross-section.

The inside and outside surfaces of conduits shall be smooth and free from burrs, flash, and similar defects. Thickness of wall shall be uniform.

The interior and ends of conduit fittings shall have no sharp edges; surface and corners over which the cables are likely to be drawn shall be smooth and well rounded.

Conduits and fittings shall have adequate mechanical strength. Conduit when bent or compressed, or exposed to impact or extreme temperatures, either during or after installation, shall show no cracks and shall not be deformed to such an extent that introduction of the cables are likely to be damaged while being drawn in.

Conduit entries of fittings shall be so designed that a reliable joint can be made between the conduit and the fittings.

Conduits and fittings shall be BS tested or approved equal.

All accessories and fittings such as bends, straps, double straps, junction boxes, bushes, etc. shall be provided as required.

### **Conduits - Metallic**

Conduits shall be constructed from solid drawn mild steel, outside and inside galvanized and shall comply with BS 4568 Part 1 & 2.

The galvanized coat of zinc shall be of uniform thickness applied to outside and inside including the threads.

Each conduit shall be straight, free from blisters and other defects, cut square and taper reamed, furnished with coupling in standard lengths, threaded each end.

Couplings shall be applied at one end of each conduit and color coded plastic threaded protectors to the other end. The interior threaded surface of each coupling shall be galvanized to ensure 100% galvanic protection on all surfaces.

The galvanized coating shall be of such quality and uniformity that a sample of the galvanized conduit will not show a fixed deposit of copper after four immersions of dips in a standard copper sulphate solution.

The galvanized coating on the conduit shall be sufficiently elastic to prevent cracking or flaking when a sample of finished conduit is bent 90 degrees at a minimum temperature of 15 degrees centigrade.

### **Conduits and Fittings-Non-Metallic**

Non-metallic conduits shall be heavy gauge, high impact rigid PVC Type A (Metric) or Type AH (Imperial) unless otherwise indicated, having a maximum continuous service temperature of 70 degree C or more. Conduits and fittings shall comply with BS 4607: Part 2:1991.

### **Conduits - Flexible**

Flexible conduit shall be constructed by square locked galvanized steel with a PVC outer covering.

### **Boxes - Metallic**

Boxes shall be constructed of cast metal as specified hereinafter.

Boxes shall be used for mounting wiring accessories. Boxes for installation in concrete shall be concrete tight. Shallow boxes shall not be used unless building construction is such that it is impossible to use standard depth boxes. Minimum acceptable depth for such boxes shall be 35 mm. Boxes shall have at least one adjustable lug and brass earth terminal.

Boxes shall be constructed of ferrous alloy cad/zinc electroplated with aluminum cellulose lacquered.

Blank covers shall be constructed of sheet steel with gasket and stainless steel screws except for damp and wet locations.

In damp and wet locations blank covers shall be constructed from cast ferrous alloy with gasket and stainless steel screws. Boxes shall be installed in walls such that they are fully aligned and flush with the wall surface after the plastering of walls.

Floor boxes shall be water tight one piece cast iron color-coated inside and out for additional corrosion resistance. Treaded steel cover shall be electro-galvanized. Boxes shall have adjusting screws.

### **Boxes - Non-Metallic**

Boxes shall be standard PVC as specified under Conduits & Fittings or phenolic material except for recess lighting outlets which shall be High Degree type.

High Degree type boxes shall be manufactured from Noryl, a thermoplastic with a higher softening temperature. Boxes shall withstand a 10 kg. load directly suspended at 100 C for 24 hours. Boxes shall incorporate pillars with threaded steel inserts.

All boxes shall be provided with earth terminals.

### **Installation of Conduits**

Conduits embedded in ceiling slab, in walls and under floor shall be non-metallic type.

Conduits exposed above false ceiling shall be non metallic type.

Exposed conduits other than above false ceiling shall be rigid steel type.

All conduit work and plastering shall be complete before wires are pulled in unless otherwise permitted by the Engineer. Conduit shall be plugged with cork and boxes covered appropriately to avoid filling with plaster.

Conduit runs between outlets shall not contain more than two quarter bends or equivalent. The maximum run between two outlets shall not exceed 25 meters for straight runs and 10 meters for runs with one or more bends. Pull (draw in) boxes shall be provided otherwise whether so indicated on the Drawings or not. Location of pull boxes shall be approved by the Engineer.

Conduits shall be installed without causing any damage to the structural members.

All bends shall be carefully made to prevent distortion of the circular cross-section. Bends made on site in conduits shall have an inside radius of not less than nine diameters.

Where bends of less than nine diameters are necessary, standard factory elbows shall be used; however the conduit size chosen shall be such as to permit a cable-bending radius within the factory elbow of at least eight times the cable diameter.

Conduits in slabs shall be installed as close to the middle of the concrete slabs as practicable without disturbing the reinforcement. The outside diameter shall not exceed one third of the slab thickness, otherwise the Contractor shall install the cable exposed on the concrete slab by approved method according to site conditions. Conduits shall be placed not closer than three diameters on centers.

Conduits in slabs shall be placed parallel to the main reinforcement steel in the slab.

Top of any conduit in slabs shall be at least 2 cm below the finishes floor surface, unless otherwise indicated or authorized.

Conduits in slabs running parallel to beam axis shall not run above beams.

### **Exposed Conduits**

Exposed conduits shall be installed parallel or at right angles to walls and ceiling beams. All changes in direction shall be made as far as possible with approved bends, elbows, and pull boxes. The spacing between parallel runs shall be uniform throughout. Unless otherwise indicated conduits shall be held securely in place by standard factory spacer bar saddles, spaced not more than 1.5, 2.0 and 2.4 meters for 20mm, 25mm and 32mm and larger conduit sizes respectively for metallic conduits and at 1 meter for non-metallic conduits.

Unless otherwise indicated, raceways exposed above false ceilings shall be supported from the slab above the ceiling in the same manner as exposed raceways. Raceways shall not be supported from false ceiling supports.

Couplings, expansion couplings, strap saddles, spacer bar saddles, spring clip saddles, conduit clips, adaptors, etc. shall all be standard factory conduit accessories.

Flexible metallic conduits shall be used only for connections to motors, or to other equipment subject to vibration or adjustment. Each connection shall contain at least one quarter bend so that no vibration can be transmitted behind the flexible connection. Flexible PVC conduits shall be used to make connections to lighting fixtures in false ceiling.

In damp and wet locations all couplings, expansion coupling, strap saddles, spacer bar saddles, spring clip saddles, conduits clips, screws, adaptors shall be corrosion proof, approved for use in damp and wet locations.

In damp and wet locations flexible conduits shall be liquid tight.

In damp and wet locations the entire conducting system, including boxes, fittings, panel boards etc.. shall be mounted so that there is at least 7 mm air space between it and the wall supporting surface.



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All conduits shall be carefully cleaned before and after installation. All ends shall be reamed free from burrs, and inside surfaces shall be free from all imperfections likely to injure the cable.

After installations of each complete new conduit run, the run shall be snaked with a band to which shall be attached an approved tube cleaner equipped with an approved cylindrical mandrel of a diameter not less than 85 percent of the nominal diameter of the conduit. All conduits through which the mandrel will not pass shall be removed and replaced by the Contractor at his own expense.

All field cuts in conduits shall be square, and cut ends shall be filed and shall have burrs removed. An insulating bushing shall be installed on each end of conduit, unless the connector is designed to prevent contact with the cut end. All connections shall be mechanically strong and tight, and made up properly with approved connectors. No running threads shall be permitted.

Conduits for TV system shall have at least 10 cm bending radius. Two bends might be necessary for the transition from floor to wall.

### **Installation of Boxes**

Boxes of ample capacity shall be provided at every junction of conduit system and as required by the Specifications.

All boxes shall be securely fastened.

Blank plates shall be installed on outlet boxes in which no apparatus is installed, or the apparatus installed does not provide a suitable cover for box.

Device boxes shall be used for all wiring devices.

Non-metallic junction/pull boxes shall be used only for concealed conduit work, and for conduit work above false ceiling.

Exposed boxes for switches, socket outlets and other devices shall be cast metal boxes.

Cast metal boxes shall be installed in such a manner that the conduit connections and the gasketed cover are dust tight. All unused openings shall be closed with pipe plugs and compound.

Boxes for similar equipment shall be mounted at uniform height within the same or similar area. Mounting shall be as shown on the Drawings.

Device box shapes and sizes shall be determined by the type and size of wiring devices for which they serve.

Boxes fixed inside false ceiling shall be provided with mounting brackets for rigid fixing to structure members or other means of support.

### **Sleeves**

Sleeves shall be provided for exposed conduit or cables passing through floor slabs and walls. All openings shall be sealed with mastic compound. The compound shall not cause any corrosion or harmful effects to the conduit. Sleeves passing through floor slabs shall be flush with the bottom of the slab, shall extend approximately 3cm above the surface of the floor and be watertight between sleeves and floor slab.

Sleeves passing through exterior walls and slabs shall be wall entrance seals of watertight construction. They shall be watertight between slab and sleeve, and between sleeve and conduit and cable. These wall entrance seals shall be of malleable iron with black paint finish and PVC sleeve, with a watertight sealing gland.

Sealing gland design shall be such that they may be tightened any time after installation. Wall entrance seals shall have oversized sleeves of proper length to position the sealing-gland housing with the wall faces.

After the cable has been pulled through the duct, a seal shall be made around it within the duct with a bituminous mastic compound, making the seal watertight.

### **Adhesives and Joints**

Conduits shall be jointed and terminated utilizing the appropriate components as supplied by the conduit manufacturer.

Permanent adhesives to produce a rigid watertight joint shall be used with standard couplers and accessories.

A flexible (non-hardening) adhesive shall be used where expansion facilities are required.

### **Expansion Joints**

Expansion coupling shall be provided at every 6 meter run of exposed conduit work, at expansion joints or as required to compensate for thermal expansion and contraction of both exposed and embedded conduits.

## **PART 3 - EXECUTION**

### **3.01 CONDUIT AND FITTINGS**

#### **I. Minimum Trade Size. 20mm.**

#### **II. Types According to Use.**

- 1- Use rigid metallic conduits for outdoor use and mechanical plant.
- 2- Use PVC conduits for indoor installations.

1-Connect all electrical equipment subject to vibration or movement with liquid-tight flexible metal conduit 60 cm minimum length. Where the equipment is located in a duct or plenum used for environmental air, the length of conduit shall not exceed 1 meter and the conduit shall be flexible metal conduit.

**Preparation.** Place sleeves in walls and floor slabs for the free passage of cables or conduits. Set sleeves in place a sufficient time ahead of concrete placement so as not to delay the work. Seal all openings and voids around sleeves through floors and walls. Be sure that plugs or caps are installed before concrete placement begins.

#### **III. Installation Requirements.**

- 1- Metallic conduits must be continuous between enclosures such as outlet, junction and pull boxes, panels, cabinets, motor control centers, etc. The conduit must enter and be secured to enclosures so that each system is electrically continuous throughout. Where knockouts are used, provide double locknuts, one on each side. For PVC terminations, provide insulated throat bushings and on rigid metallic conduits, provide nonmetallic insulating bushings for conductor protection. Where conduits 1-1/2 inches and larger terminate in equipment having a ground bus, such as in switchgear, motor control centers and panel boards, provide conduit with an insulated grounding bushing and extend a suitable grounding wire to the ground bus.
- 2- Have rigid nonmetallic conduit adequately solvent welded at joints to form a tight, waterproof connection.
- 3- Run concealed conduit as directly and with the largest radius bends as possible. Run exposed conduit parallel or at right angles to building or other

construction lines in a neat and orderly manner. Conceal conduit in finished areas. Unless otherwise shown, remaining conduit may be exposed. Provide chrome-plated floor and ceiling plates around conduits exposed to view and passing through walls, floors, partitions, or ceilings in finished areas. Select properly sized plates to fit the conduit when securely locked in place.

#### **IV. Installation Methods.**

- 1- Install each entire conduit system complete before pulling in any conductors. Clean the interior of every run of conduit before pulling in conductors to guard against obstructions and conduit omissions.
- 2- Cut all joints square, then thread and ream smooth. Coat cuts, threads or scratches on steel conduit with an approved zinc chromate or with a 90 percent zinc paint. When dry, draw up tight.
- 3- Make bends with standard ells or conduit bent in accordance with the IEC. Make field bends using equipment designed for the particular conduit material and size involved. Bends must be free from dents or flattening. Use no more than the equivalent of three 90-degree bends in any run between terminals and cabinets, or between outlets and junction boxes or pull boxes.
- 4- Conduit bodies may be used in lieu of conduit ells where ease of installation and appearance warrants their use. Conduit bodies larger than 1 inch may be used only where approved.

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- 5- Securely fasten and support conduit to structure or metal framing using hot-dipped galvanized, malleable iron pipe straps or other approved means. Wires of any type may not be used for securing conduits.
- 6- Provide a No. 30 nylon pulling line in conduits in which wiring is not installed under this work. Identify both ends of the line by means of labels or tags reading "Pulling Line - Telephone," etc.
- 7- Suitably cap conduit during construction to avoid water, dirt and trash entrance.
- 8- Use expansion-deflection fittings on conduit crossing structural expansion joints and on exposed conduit runs where necessary. Provide bonding jumpers across fittings in metal raceway systems.
- 9- With a coupling, terminate concealed conduit for future use at structural surfaces. Install a pipe plug flush with the surface.
- 10- Openings around electrical penetrations of fire-resistance rated walls, partitions, floors or ceilings shall be fire stopped using fire stopping materials(mortar, jacket, cast-in-device.....etc)"similar to Hilti products" to maintain the fire resistance rating using approved methods.

END OF SECTION

**SECTION 14123**  
**600 - VOLT CABLE**

**PART 1 GENERAL**

**1.01 SUMMARY**

- I. Single and multi core insulated power conductors rated 600 volts, sized larger than 10 mm<sup>2</sup>.

**1.02 RELATED WORK**

- I. Grounding and Bonding Section
- II. Wiring Section
- III. Equipment Identification Section

**1.03 REFERENCE STANDARDS**

- I. Jordanian codes
- II. Local Utilities regulations
- III. B.S. 6360, 6004, 6207, 6476, 6346, 5468
- IV. IEC 228, 287, 502

**1.04 SUBMITTALS**

- I. Provide Product Data and manufacturers literature
- II. Provide Operation and Maintenance Data
- III. Submit blank test sheets for approval
- IV. Submit completed factory any site test sheets
- V. Sample of cable pulling lubricant

**PART 2 - PRODUCTS**

**2.1 GENERAL**

- I. Cables shall be one, three or four core consisting of 99% conductivity, plain annealed stranded copper conductors rated at a normal maximum operating temperature of 90 degrees C.

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- II. Provide a PVC overall jacket on all cables, with a durable marking on the surface of the jacket at intervals not exceeding 610mm. marking shall include manufacturers name, conductor size and voltage class of cable.
- III. Cable ampacity and electrical characteristics shall conform with specified codes and standards.
- IV. Provide a ground wire with each circuit sized as indicated on drawings. Ground wire shall be bare, concentric lay copper.
- V. Where armoring is required, it shall be steel wire armour on single core cables and galvanized steel wire armour on multi-core cables.

### **2.2 SPLICES AND TERMINATION**

- I. Cable splices and terminations shall be furnished in kit form and shall conform to the recommendations of the cable manufacturer. All material shall be furnished in factory sealed packages and shall not be opened until required for use.
- II. Splices shall be suitable for installation in manholes
- III. Terminal connectors shall be pressure; bolted clamp type or compression type.

### **3 CABLE TIES AND CABLE MARKERS**

- I. Lacing material for site installed cable shall be non-releasing nylon ties.
- II. Tie-on cable markers shall be provided in accordance with the equipment identification specifications section.

### **4 WIRING**

- I. Single core 600 volt cable of size 10 mm<sup>2</sup> and less is specified in the wiring specification section.

### **5 CU/XLPE/SWA/PVC:**

- I. To BS 5468, 1000V grade
- II. Conductors : Plain annealed copper to BS 6360
- III. Cables shall comprise plain copper, stranded circular conductors insulated with an adequate thickness of extruded cross linked polythene (XLPE).
- IV. Conductors shall be laid up together and wormed circular with suitable pre-formed fillers and wormings, bound with polythene terephthalate (PTP) tape and covered with an extruded PVC sheath minimum 1.4 mm thick.
- V. Multicore cables shall have steel wire armouring, extruded sheath of black PVC.
- VI. Single core cables shall be unarmoured, unless otherwise specified on drawing, with an extruded black PVC outer sheath.
- VII. Outer sheath of single and multicore shall be at least 2.5mm thick.
- VIII. Design electrical stress at any point in the insulation shall not exceed 3KV per mm.

- IX. Conductor screen: non-metallic comprising either:
  - 1- Semi-conducting tape; or
  - 2- A layer of extruded semi-conducting material.
- X. The electro-static screen over insulation shall comprise a non-metallic layer of semi-conducting tape or extruded semi-conducting material applied over the insulation and in direct contact with it, followed by a layer of copper tape applied helically over the semi-conducting layer to ensure close contact throughout.
- XI. Prevent void formation in insulation by careful control of its passage through the temperature graded water baths.

### **PART 3 - EXECUTION**

#### **3.1 INTERNAL CABLE INSTALLATION**

- I. Support internal horizontal and vertical runs on cable tray using non-ferrous clamps at 1 meter intervals.
- II. Arrange multicore cables to run parallel on tray with a lateral spacing of the diameter of the largest cable.
- III. Arrange single core cables with phases in trefoil formation providing one cable diameter space between trefoil groups.
- IV. Where cables are routed through walls or floors, the opening between the cables and the structure shall be sealed such that the fire resistance of the sealing barrier is at least as great as the surrounding structure.

#### **3.2 EXTERNAL CABLE INSTALLATION**

- I. Immediately prior to the placement of each cable or cable group, the raceway route to be followed shall be inspected and ascertained to be complete in installation and free of all materials detrimental to the cable or its placement. All cables assigned to a particular duct or conduit shall be grouped and pulled in simultaneously, using cable grips or pulling eyes and acceptable lubricants.

All cables shall be carefully checked both as to size and length before being pulled into conduits or ducts. Cable pulled into the wrong conduit or duct or cut too short to rack, train, and splice as specified herein, shall be removed and replaced.

- II. **Cable in Shafts etc.:** Cable shall be supported at all times without short bends or excessive sags and shall not be permitted to lie on the manhole floor. Cable ends must not be submerged. Cable racks, saddle supports or trays shall be provided for permanent support. Temporary support required during placement shall be with rope slings, timbers, or alternate method acceptable to the Client Engineer.

Cable shall be located in manholes to provide minimum interference with other cables to be installed or installation of future cables in spare conduits.

- III. **Cable Pulling** : Pulling shall be done with nylon or rope recommended by cable manufacturer.
- IV. **Cable Grips**: Factory installed pulling eyes shall be used for pulling cable where they are available. Woven wire cable grips shall be used to pull all single conductor cable, 70 mm<sup>2</sup> and larger, where pulling eyes are not available, and all multi conductor cable. Pulling loops shall be used to pull single conductor cable smaller than 70 mm<sup>2</sup>. When a cable grip or pulling eye is used for pulling, the area of the cable covered by the grip or seal plus 150 mm shall be cut off and discarded when the pull is completed.

As soon as the cable is pulled into place, the pulling eyes, cable grips, or pulling loops shall be removed and any cable which was sealed shall be resealed.

- V. **Inspection**: The outside of each cable reel shall be carefully inspected and protruding nails, fastenings, or other objects which might damage the cable shall be removed. A thorough visual inspection for flaws, breaks, or abrasions in the cable sheath shall be made as the cable leaves the reel, and the pulling speed shall be slow enough to permit this inspection. Damage to the sheath or finish of the cable shall be sufficient cause for rejecting the cable. Cable damaged in any way during installation shall be replaced.
- VI. **Pulling Tension**: The pulling tension of any cable shall not exceed the maximum tension recommended by the cable manufacturer. Pulling mechanisms of both the manual and power types used by the Contractor shall have the rated capacity in tones clearly marked on the mechanism. Whenever the capacity of the pulling mechanism exceeds the recommended pulling tension of the cable as given by the cable manufacturer, a dynamometers shall be used to show the tension on the cable and the indicator shall be constantly watched. If any excessive strain develops, the pulling operation shall be stopped at once and the difficulty determined and corrected.
- VII. **Sidewall Pressure**: To avoid insulation damage from excessive sidewall pressure at bends in duct and conduit runs, the pulling tension in kilograms at a bend shall not exceed 445 times the radius of the bend in meters.
- VIII. **Cable Bends**: Extreme care shall be exercised during the placement of all cable to prevent tension and bending conditions in excess of the manufacturer's recommendations. The permanent radius of bend after cable installation shall be in accordance with the cable manufacturer's recommendations but not less than 6 times overall diameter.
- IX. **Supports**: All cable supports and securing devices shall have bearing surfaces located parallel to the surfaces of the cable sheath and shall be installed to provide adequate support without deformation of the cable jackets or insulation.  
  
Final inspection shall be made after all cable is in place and, where supports, bushings, and end bells deform the cable jacket, additional supports shall be provided. Additional cable protection such as a wrapping of light rubber belting, friction tape, or similar materials shall be provided when required. Cable in vertical runs shall be supported by woven wire grips in accordance with the Code requirements.
- X. **Cable Identification**: The Contractor shall identify all cables in the locations specified in other sections.
- XI. **Moisture Seals**: Each cable shall be kept sealed except when termination and splicing work is being performed.



The ends of all cables shall be sealed with heat shrinkable caps. Cap sizes shall be as recommended by the cap manufacturer for the cable outside diameter and insulation. Caps shall contain sufficient adhesive that shrinkage of the cap during application results in formation of a positive watertight seal capable of withstanding complete immersion or total exposure without permitting the entrance of moisture.

Before and after pulling, the leading and seal of each length of cable shall be examined and repaired if necessary. All cut cable ends shall be promptly sealed after cutting except those to be spliced or terminated.

- XII. **Crimping Tools:** Crimping tools used to secure conductors in compression type connectors or terminal lugs shall be those made for that purpose and for the conductor sizes involved. The crimping tools shall accurately crimp the conductor insulation support sleeve where provided. Crimping tools shall be provided with guides to position connectors in the crimping, and shall be of a type which prevents the tools from opening until the crimp action is completed. Crimping tools shall be a product approved by the connector manufacturer. The Contractor shall establish and maintain a tool certification program to ensure that crimping tools are kept in accurate operating condition.
- XIII. **Termination:** Cable shall be terminated in accordance with the following requirements.
- 1- Train cable in place and cut squarely to required length. Avoid sharp bends.
  - 2- Install terminals or terminal connectors as required, ensuring a firm metal-to-metal contact.
  - 3- Insulate each connection of cable to an insulated conductor (whether cable, bus, or equipment bushing). The insulation shall cover all exposed surfaces of the conductors; the insulation voltage level of the completed termination shall be not less than the insulation voltage level of the connected conductors. Insulation of terminations shall be as specified in the following paragraphs.
- XIV. **Insulation of Termination in 600 volt Cable:** Terminations which require insulation in cable rated 600 volts or less shall be insulated in accordance with the following requirements:
- 1- All exposed conductor and connector surfaces shall be covered with a minimum of three half-lapped layers of self-vulcanizing rubber insulating tape.
  - 2- A minimum of three half-lapped layers of polyvinyl chloride electrical tape shall be applied over the rubber tape. The polyvinyl chloride tape shall extend a minimum of two cable diameters over the cable jacket and a similar distance over other conductor insulation or connector requiring insulation.

### 3.3 CABLE TESTING

- I. **General:** All insulated conductors shall be electrically tested before ( factory certificate & RSS certificate) and after placement on site where the engineer shall be present.

All circuits shall be tested with the circuit complete except for connections to equipment. all splices, stress cones on shielded cable, and terminal connector attachments shall be complete prior to testing.

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Any circuit failing to test satisfactorily shall be replaced or repaired and then retested.

All equipment and labor required for testing shall be provided by the Contractor.

- II. Continuity, Identification, and Short Circuit Tests: All insulated conductors shall be tested for continuity and conductor identification. In addition, all insulated conductors of multi conductor cable shall be tested for short circuits. The Contractor shall furnish portable, battery powered, ring testers, and other test equipment as required to conduct these tests.

Continuity tests shall include all tests necessary to confirm that the conductor being investigated originates and terminates at the locations designated on the drawings.

Short circuit tests shall include all tests necessary to confirm that no conductor of a multi conductor cable is short circuited to another conductor in that cable.

- III. Insulation Tests: Resistance from ground provided by the insulation on all site installed insulated conductors shall be measured. Measurement shall be accomplished as follows.
- IV. All 600 volt insulated conductors shall be tested with a 1,000 volt calibrated megger or an equivalent testing device. Insulation resistance measurements shall be made between each conductor and ground and between each conductor and all other conductors of the same circuit. Minimum acceptable resistance values shall be approximately infinite.
- V. Comprehensive insulation test reports have to be submitted and approved by the Client Engineer before energizing.

END OF SECTION

**SECTION 14130**  
**BOXES**

**PART 1 - GENERAL**

**1.01 SUMMARY**

This section specifies the furnishing and installation of outlet and switch boxes, floor boxes, junction boxes and pull boxes.

**1.02 REFERENCE STANDARDS**

- I. Jordanian codes
- II. BS4607 PVC boxes
- III. IEC-670
- IV. BS 1363
- V. BS-4662

**1.03 SUBMITTALS**

- I. Provide product data on the following:
  - 1- Floor boxes.
  - 2- Fire-rated poke-through units.

**PART 2 - PRODUCTS**

**2.01 OUTLET BOXES**

- I. **Flush Wiring Accessories Boxes.** Provide PVC boxes of sufficient size to accommodate wiring accessories to be installed at outlet or switch. Provide an extension ring for the device(s) to be installed. Square or rectangular boxes may be used. Unless otherwise noted, provide minimum 3.5 cm deep by 7 X 7 cm minimum size box.
- II. **Exposed Wiring Accessories Boxes.** Provide PVC boxes for surface mounting in areas having exposed rigid PVC conduit systems and mettalic boxes for surface mounting in areas having exposed rigid mettalic conduits.
- III. **Boxes for Lighting Fixtures.** Provide PVC circular boxes as required to properly support ceiling and bracket-type lighting fixtures. Unless otherwise noted, provide 3 cm deep by 6 cm diameter.
- IV. **Masonry Boxes.** Provide galvanized steel, 3.5 cm deep, masonry boxes for all devices installed in masonry walls.

## 2.02 JUNCTION, PULL AND SPLICE BOXES

- I. **Construction.** Provide PVC boxes conforming to BS 4607.
- II. **Interior Spaces.** Provide BS 4662 type boxes at least 3.5 cm deep.
- III. **Exterior Spaces.** Provide BS 4662 12X type boxes at least 3.5 cm deep.
- IV. **Embedded.** Provide BS 4662 12X cast iron type with flush flanged cover when cast in concrete.

## 2.03 FIRE-RATED POKE-THROUGH UNITS

- I. **Construction.** Through-floor units shall comply with BS 4662.
- II. **Fire Rating.** Through-floor units shall be classified with a fire rating of 2 hours in a floor which is 6 cm thick.
- III. **Box and Conduit.** Underfloor junction box and conduit shall be self-supporting without the attachment of an above-floor fitting. The integral fire barrier must incorporate a cold smoke barrier to prevent the passage of smoke when heat is not present. The junction box shall be 12 cm square by 8 cm deep with knockouts to accommodate up to 1-inch conduits. Box and conduit shall be provided with separation barriers for combination power and communication units. Through-floor unit shall allow replacement of original service fittings with different style service fittings of similar or dissimilar service function, including abandonment condition.
- IV. **Above-Floor Fittings.** Provide die-cast aluminum above-floor fitting with satin chrome finished cover. Provide a combination power and communication fitting. Power section shall be equipped with a 15-ampere, 220-volt. Communication section shall have a cover plate with a 5/8-inch bushed opening.

## PART 3 - EXECUTION

### 3.01 OUTLET BOXES

- I. **Flush Boxes.** Unless otherwise indicated, mount all outlet boxes flush within 6 mm of the finished wall or ceiling line. Provide extension rings where required to extend the box forward in conformance to BS and IEC requirements. Attach ring with at least two machine screws. Securely fasten outlet boxes. Provide plaster covers for all boxes in plastered walls and ceilings.
- II. **Fixture Boxes.** Where boxes for suspended lighting fixtures are attached to and supported from suspended ceilings, adequately distribute the load over the ceiling support members.
- III. **Mounting Height.** Mounting height of a wall-mounted outlet box means the height from finished floor to horizontal center line of the coverplate. Where outlets are indicated adjacent to each other, mount these outlets in a symmetrical pattern with all tops at the same elevation. Where outlets are indicated adjacent, but with different mounting heights, line up outlets to form a symmetrical

vertical pattern on the wall. Verify the final location of each outlet with Owner's representative before rough-in. Remove and relocate any outlet box placed in an unsuitable location.

- IV. **Back-to-Back Boxes.** Do not connect outlet boxes back to back unless approval is obtained from the Owner's representative. Where such a connection is necessary to complete a particular installation, fill the voids around the wire between the boxes with sound insulating material.
- V. **Box Openings.** Provide only the conduit openings necessary to accommodate the conduits at the individual location.

### 3.02 FLOOR BOXES

- I. Verify locations of all floor boxes with the Owner's representative before installation. Completely envelope floor boxes in concrete except at the top. Increase slab thickness at boxes if required to obtain a minimum of 30 mm of concrete below bottom of box. Adjust covers flush with finished floor.

### 3.03 JUNCTION AND PULL BOXES

- I. **Installation.** Install boxes as required to facilitate cable installation in raceway systems. Generally provide boxes in conduit runs of more than 30 meters or as required in Section 16110.
- II. **Covers.** Provide boxes so that covers are readily accessible and easily removable after completion of the installation. Include suitable access doors for boxes above inaccessible ceilings. Select a practical size for each box and cover.

### 3.04 FIRE-RATED POKE-THROUGH UNITS

- I. **Installation.** Floor slab or deck shall be core-drilled to accept through-floor conduit unit. Install per manufacturer's recommendations.

END OF SECTION

**SECTION 14140  
WIRING ACCESSORIES**

**PART 1 - GENERAL**

**1.01 SUMMARY**

This section specifies the furnishing and installation of wiring accessories and plates.

**1.02 REFERENCE STANDARDS**

- I. Jordanian codes
- II. BS 3676 Pt.1 :1989, BS EN60947-3 lighting Switches .
- III. BS1363 Pt.2:1995, BS 4343, 546 and 196– Socket Outlets and plugs.
- IV. BS 1363 Pt 4:1995- connection units DP Switches.
- V. BS 5733: 1995 grid switches.
- VI. BS 6972, 6141 and 5733 for ceiling roses.

**1.03 SUBMITTALS**

- I. Provide product data on wiring devices and plates.

**PART 2 – PRODUCTS**

**General**

The Contractor shall supply and install all of the wiring devices as indicated on the Drawings and as herein specified.

Wiring devices shall be flush mounted type, unless otherwise noted and shall be installed at heights as shown on the Drawing, or as directed by the Engineer.

Wiring devices fixed on glazed tiles shall include a rubber gasket between the cover plate and the glazed tiles for rigid fixing of the device plates. The gaskets shall not protrude beyond the plate: they shall be neatly cut in the shape of the plate.

Unless otherwise specified or indicated on the Drawings, plates for flush mounting devices shall be constructed of moulded material of ivory or white in colour.

Samples of devices and plates shall be submitted for approval of the Engineer.

**Device Plates**

Plates shall be rectangular or square in shape to the approval of the Engineer.

Plates shall be designed to match associated devices.

Plates for cord extension shall be provided with cord grip bushings, threaded type, of same material and finish as of plate.

Unless otherwise specified or indicated on the Drawings, plates for flush mounting devices shall be constructed of moulded material of ivory or white in colour.

Fixing screws shall be chromium plated and polished. Screw heads shall be finished to suit the plates.

### **Switches**

Switches shall be rocker operated mounted with the operating handle in the upward position when in the "ON" position unless otherwise directed by the Engineer.

Switches shall interrupt the hot wire or hot and neutral simultaneously as applicable.

Switches shall be quick-make, quick-break, with silver alloy contacts, trunnions and spring assembly lubricated for the life of the switch neoprene bumpers.

Lighting Switches shall be 250 volt ac only, 10 mp rating to BS 3676 Part 1.

Switches shall be fully rated for tungsten filament and fluorescent lamp loads, and up to 80% of rated capacity for motor loads.

Switches shall be one gang or multigang, 1-way, 2-way or intermediate as indicated on the drawings and to the approval of the Engineer.

Key operated lighting switch shall be 20 amp rated, one way single pole.

20-Amp double pole switches shall incorporate a pilot light, and shall have the words "Water Heater" engraved on it when used for that propose.

30-Amp double pole switch shall incorporate the inscription indicating the purpose of its use.

### **Grid Switch Assemblies**

Switch assemblies shall be of the gridswitch system, comprising rocker-operated grid switches and coverplates of moulded material with white finish, unless otherwise indicated.

Switch assemblies shall comprise 20-amp lighting switches, and other units if so indicated on the Drawings.

.Switch assemblies shall have the words "Danger 400 volts" engraved in red in it.

### **Timer Switches**

Timer switches shall be 20-amp rated, one pole, one throw with one "OFF" and one "ON" levers. Switch shall be 30 minute dial type, recess mounted. Switches shall have 20,000 switching cycles guaranteed life.

## **Lighting Contactor Control Pushbuttons**

Pushbuttons shall be double contact type with spring return action.

Body shall be made of molded plastic with clear baked acrylic protection.

### **Socket Outlets**

Socket outlets shall be mounted with correct polarity, such that switch shall cut the hot wire.

Socket outlets shall be of the standard, 3-pin, switched, single phase, shuttered type of moulded plastic unless otherwise specified.

13-amp socket outlets shall be flat pin type, to BS 1363, single or twin as indicated.

15-amp socket shall be round pin switched type to BS 546.

### **Protective Socket Cover**

Weatherproof socket outlets shall be provided with protective socket covers.

Protective socket cover shall be manufactured from high impact resistant "Noryl". The cover shall be designed to fall by gravity over the socket whether a plug is inserted or not.

### **Ceiling Roses**

Ceiling roses shall be designed to meet the requirements for the installation of flexible pendent cords for lighting. They shall be moulded in a non-track insulating material to BS 6972, 5733 and 6141 and shall be 3 pin plug in ceiling roses.

Ceiling roses shall incorporate 3 terminals (one of which properly shrouded), loop-in, earth and strain. The shrouded terminal shall be used for the live unswitched wires.

All lighting fixtures incorporated in a false ceiling shall be connected to the ceiling lighting outlet through a ceiling rose and a flexible cord.

### **Fan Coil Power Outlet/Fused Connection Unit**

Power outlets for fan coil units ceiling mounted shall be flush surface mounting 13-amp fused connection units incorporating double pole switch, neon indicator and fuse of appropriate rating, in a 2-gang device box, with the second gang covered with a blank plate.

Outlet for fan coil units with heaters ceiling mounted shall be surface mounting type and shall comprise a 20-amp double pole switch for the fan motor and a 50-amp double pole switch for the heater.

Outlet for fan coil units installed at low level shall be a recess mounting 13-amp fused connection unit incorporating a double pole switch, neon indicator, fuse of appropriate rating and flex outlet.

Outlet for fan coil units with heaters installed at low level shall be a recess mounting 25-amp twin double pole switch with two flex outlets or alternatively a 20-amp and a 50-amp two double pole switches with two flex outlets.

### **Voice**

Voice outlets shall be RJ11 type and shall consist of terminal blocks of high insulating phenolic block with non-ferrous screws and straps.



### **Control Stations**

Control stations shall be spring type, with silver plated contacts. Contacts shall be 5 amp rated. Plate shall be constructed from aluminium gray baked enamel painted.

ON-OFF maintained contact station shall have two pushbuttons, one green for ON and one red for OFF. A green pilot light shall be incorporated which shall lit when pushbutton ON is depressed. The words ON & OFF shall be engraved on the pushbuttons in white.

START-STOP momentary contact type station shall have two pushbuttons, one green for START and one red for STOP. A green pilot light shall be incorporated which shall lit when pushbutton START is depressed. The word START & STOP shall be engraved on all motor control stations.

UP-STOP-DOWN momentary contact type stations shall have three pushbuttons and no pilot lights.

Pushbuttons shall be moulded from trac-resistant material, and shall be provided with button shrouding ring.

Key switch shall be a cylinder lock operator type station with three positions UP-OFF-DOWN. These words shall be engraved on the station.

Stations in damp & wet locations shall be enclosed in a Feraloy box and covered with stainless steel plates.

When line voltage is 380-415 and the control is line-to-line connected as described under MOTORS & STARTERS", a warning notice shall be inscribed in the device in a clearly visible manner once the cover is removed.

### **Cable Outlet**

Cable outlet shall comprise a moulded cover plate with a side groove for 3 x 10 mm<sup>2</sup> multicore flexible cord, a cable clamp, 3 terminals for 10 mm<sup>2</sup> conductors.

Cable outlet shall be similar to Crabtree 4506, MK 5045 to the approval of the Engineer.

### **Fireman's Emergency Switch**

Fireman's emergency switch shall be 16 Amp double pole or four pole as applicable. It shall incorporate a neon light. Opening of cover shall not be possible when live. It shall be protected against dust and splash of water to IP54.

## **PART 3 - EXECUTION**

### **3.01 DEVICE COORDINATION**

- I. Where items of equipment are provided under other sections of this specification or by the Owner, provide a compatible receptacle for the cap or plug and cord of the equipment.

### **3.02 WALL SWITCHES**

- I. Location. Set wall switches in a suitable switch box centered at the height of 130 cm from the floor, except as otherwise shown. Install switch on the strike side of the door as finally hung.
- II. Position. Install wall switches in a uniform position so the same direction of operation will open and close the circuits throughout the job, generally up or to the left for the ON position.

### **3.03 SOCKET OUTLETS**

Mount socket outlets vertically with the ground on top in a suitable pvc outlet box centered at the height of 40 cm from the floor or as shown on the drawings. For horizontally mounted outlets, ground should be on left. The engineer reserves the right to make any reasonable changes in outlet locations without change in the contract sum.

### **3.04 DEVICE PLATES**

- I. Type. Provide device plates for each outlet of the type required for service and device involved.
- II. Ganged Devices. Mount ganged devices under a single, one-piece, device plate.
- III. Engraving. Engrave plates with 3mm-high black letters, if designated for engraving.

**END OF SECTION**

**SECTION 14261  
CONTROL PANEL UNINTERRUPTIBLE POWER SUPPLY  
(SINGLE-PHASE)**

**PART 1 GENERAL**

**1.01 SCOPE OF WORK**

- A. Labor, equipment, supervision and materials for the installation, testing, startup, and training for the uninterruptible power supply (UPS) as shown on the Drawings and as specified herein.

**1.02 RELATED WORK**

- A. Section 16000 – Electrical – General Provisions.
- B. Section 16141 – Wiring Devices.
- C. Section 16950 – Electrical Acceptance Tests.

**1.03 SUBMITTALS**

- A. Submittals shall be in accordance with Sections 01300 and 13300. Submittals shall include shop drawings and product data, for the following:
  - 1. Product brochure.
  - 2. Bill of materials listing all components provided.
  - 3. Deviation list indicating all proposed exceptions.
  - 4. Power single line and control schematics drawings. All external connection details and their terminal block locations shall be fully detailed. All internal wiring shall include terminal numbers and color coding.
  - 5. UPS performance specifications:
    - a. kVA rating.
    - b. Input and output voltage and phase.
    - c. Run time at full and half load.
    - d. Voltage (output regulation, input tolerance, unbalance, transfer/retransfer voltage, etc.).
    - e. Heat rejection.
  - 6. Operating Instruction manuals and recommended replacement parts.
  - 7. Name, address, and telephone number of the nearest service facility.
  - 8. Training agenda and information per Section 01758.
  - 9. Battery specifications and warranty.
  - 10. UPS Loading and battery sizing calculations to support runtimes as specified herein.

**1.04 REFERENCE STANDARDS**

- A. ANSI C62.41/IEEE 587 - Standards for Surge Withstandability.

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- B. FCC (Federal Communications Commission) Rules and Regulations, Part 15, Subpart B, Class A certified compliance.
- C. UL (Underwriters Laboratories) 1778 Listed (Rev. Jan 5, 2000), UL497A
- D. CSA 22.2, No. 107.1 M95 AND 107.2.
- E. IEC 62040-2 Emission and Immunity.
- F. IEC 62040-3 (Uninterruptible Power Systems, Part 3).
- G. EN 60529 Equipment Protection.
- H. National Electric Code (NFPA-70).
- I. ISO 9001.

### 1.05 DELIVERY, STORAGE AND HANDLING

- A. Provide delivery, storage and handling in accordance with Section 01600 and per the following:
  - 1. Store the equipment indoors in a clean, dry, heated storage facility until ready for installation. Do not install the equipment in its final location until the facilities are permanently weather tight. Furnish, install and wire temporary electric space heaters in the equipment until the permanent heating equipment is operational. Protect the equipment at all times from exposure to moisture and chemicals.

### 1.06 QUALITY ASSURANCE

- A. UPS systems shall utilize a field proven design. The UPS manufacturer shall demonstrate at least ten years of continuous field operating experience with equipment of similar size and design.
- B. Equipment shall be UL or ETL labeled.
- C. The UPS manufacturer shall have ISO 9001 certification.
- D. The UPS system shall meet or exceed the theoretical Mean-Time-Between-Failures (MTBF) for a Single module UPS operation (represents UPS module operation only) of 140,000 MTBF hours.

### 1.07 WARRANTY

- A. Refer to Section 01740.
- B. UPS: In addition to the basic warranty, the UPS manufacturer shall provide a standard warranty for the UPS for a period of one year from the date of purchase. The Contractor shall provide an additional one year extended warranty to cover delays associated with equipment startup or date of receipt by end user, whichever occurs first.
- C. Battery: In addition to the basic warranty, the UPS manufacturer shall provide a standard warranty for the batteries for a period of one year from the date of purchase. The Contractor shall provide an additional one year extended warranty to cover delays associated with equipment startup or date of receipt by end user, whichever occurs first.

PART 2 PRODUCTS

2.01 SINGLE-PHASE UPS - EXTERNAL TO CONTROL PANEL

A. SYSTEM DESCRIPTION

1. Provide a continuous-duty, on-line, solid state, dual conversion, single-phase input (using input voltage as shown on the drawings), single-phase 230VAC true sinewave output uninterruptible power system.
2. The UPS shall provide power conditioning and power backup for computer, communication, and other critical electronic loads as indicated on the Drawings.
3. The UPS system shall consist of the following major components:
  - a. Rectifier and battery charger.
  - b. Inverter.
  - c. Batteries and battery disconnect switch.
  - d. Automatic static bypass switch.
  - e. External maintenance bypass switch.
  - f. Integral control and monitoring panel.
  - g. Other features as described in this specification and as indicated on the Drawings.
4. The UPS shall be manufactured by one of the following:
  - a. Liebert GXT2 Series.
  - b. Eaton Powerware.
  - c. Schneider Electric APC Smart-UPS.
  - d. Ametek Solid State Controls
  - e. Tripp Lite
  - f. Or equal.

B. General Requirements

1. External Battery Enclosure: A separate enclosure shall be provided for housing additional batteries if required to provide the minimum run time as specified herein. The battery enclosure shall match the main UPS enclosure in style and color.
2. All cabling required to interconnect all components of the UPS system shall be provided by the UPS manufacturer.
3. Battery protection shall be provided an internal circuit breaker disconnect. Battery cabinets shall be protected by an internal circuit breaker.
4. Current limiting circuitry shall protect the inverter output under any load condition. High speed semiconductor fusing shall protect the static bypass in the event of an output short circuit.
5. The AC output neutral shall be electrically isolated from the UPS chassis. The UPS chassis shall have an equipment ground terminal. Provisions for installation of a bonding connector shall be provided.
6. The UPS shall be suitable for installation at the location as shown on the Drawings.

C. Performance Requirements - Ratings

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1. Battery runtime: Provide batteries to support 125% of calculated load for 20 minutes. Provide additional batteries in separate enclosure as required to meet the runtime requirement.
2. Output power: Provide 3kVA minimum recommended ratings for the UPS

### D. Performance Requirements -Environment:

1. Ambient temperature: 0 to 40 degrees C.
2. Elevation: Project site elevation
3. Relative humidity: 0 to 95 percent non-condensing

### E. Electrical Requirements:

1. System Input – Primary source:
  - a. Single input: 230 VAC
  - b. Frequency: 50 Hertz plus or minus five percent.
  - c. Input Power Factor: 0.8 lag minimum, 50 to 100 percent load.
  - d. Input Current Total Harmonic Distortion (THD): <33 percent.
  - e. Input Surge Withstandability: Per IEEE 587/ANSI C62.41. Category A and B, (3 kV).
  - f. Input Connection: Coordinate with electrical contractor.
2. System Output:
  - a. Nominal Output Voltage: As indicated herein and as shown on the Drawings.
  - b. Frequency: 50 Hertz plus
  - c. 100 percent load with 3:1 Crest Ratio
  - d. Frequency Slew Rate: 1 Hz/second. (Adjustable at startup)
  - e. Output Connections: (six) NEMA 5-15R receptacles.
3. AC to AC Efficiency: (100 percent load @ rated PF): 91 percent
4. Acoustical Noise: Noise generated by the UPS under normal operation shall not exceed 65 dBA (60 dBA typical) at one meter from any surface, measured at 25 degrees C (77 degrees F) and full load.
5. EMI Suppression: The UPS shall meet FCC Rules and Regulation 47, Part 15, Subpart B, for Class A devices.

### F. Modes of Operation

1. Normal Mode: The UPS shall be a continuous online unit. Power to the critical loads shall be continuously generated by the inverter during normal AC line power. In the event of AC line power failure, power to inverter is supplied by the batteries. Under normal operation, the batteries shall be charged in a manner that optimizes battery life. Simple "trickle charge" of the batteries shall not be acceptable.
2. Bypass Mode: The automatic bypass shall transfer the critical load to the commercial AC source, bypassing the UPS' inverter/rectifier, in the case of an overload, load fault, or internal failure.
3. Maintenance Mode: If a Maintenance Bypass switch is provided, the external manual bypass switch shall be operated to transfer the load to the alternate source

when the UPS is taken out of service for maintenance or repair. This transfer shall occur without interruption.

G. Controls

1. Microprocessor-controlled circuitry: Fully automatic operation of the UPS shall be provided through the use of a microprocessor-based controller. All operating and protection parameters shall be firmware-controlled. The logic shall include system test capability to facilitate maintenance and troubleshooting. Startup, battery charging, and transfers shall be automatic functions.
2. Graphical Display: The UPS control panel shall utilize an LED graphical display for all UPS control, monitoring, alarming, configuration and diagnostic functions. The following operational controls and indicators shall be provided on the UPS control panel per the following KVA ranges:

H. Remote alarm and status indication: Isolated SPDT Form C dry contacts shall be provided to indicate UPS status for remote monitoring. Contacts shall be rated for 250VAC @ 5A or 30VDC @ 5A. Individual contacts shall be provided for separate annunciation of the following

1. UPS Normal (UPS is using utility power to power the load and detects no faults)
2. UPS in Static bypass mode
3. UPS using battery to power the load
4. UPS on battery and battery low
5. For the external maintenance bypass switch is provided, provide a contact from that switch to indicate UPS in Maintenance Bypass mode.

I. RECTIFIER/CHARGER

1. The term rectifier/charger shall denote the solid-state equipment and controls necessary to convert incoming AC power to regulated DC power for input to the inverter and for battery charging. The rectifier/charger shall be a solid-state SCR/IGBT power transistor type with constant voltage/current limiting control circuitry.

J. INVERTER

1. The inverter shall include all solid-state equipment and controls to convert DC power from the rectifier/charger or battery to a regulated AC power for powering the critical load. The inverter shall use Insulated Gate Bipolar Transistors (IGBTs) in a phase-controlled, pulse width modulated (PWM) design capable of providing the specified AC output.
2. The inverter shall be capable of supplying current and voltage for overloads exceeding 100 percent. The inverter is to provide 150 percent of full load for 30 seconds and 125 percent of full load for 2 minutes. A status indicator and audible alarm shall indicate overload operation. The UPS shall transfer the load to bypass when overload capacity is exceeded.

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3. The output voltage shall be maintained to within plus or minus 4 percent.
4. The output voltage total harmonic distortion (THD) shall not be greater than 5 percent for all loads. For 100 percent rated load of 3:1 crest factor nonlinear loads, the output voltage total harmonic distortion shall not be greater than 4 percent. The output rating shall not be derated in kVA or kW due to the 100 percent nonlinear load with 3:1 crest factor.
5. The inverter shall use software control to adjust the output voltage from plus or minus 5 percent of the nominal value.

### K. BATTERIES

1. The batteries shall be VRLA (valve-regulated lead-acid), sealed, maintenance-free, high-rate discharge, lead-acid cells suitable for use indoors with no offgasing or water addition requirements. Batteries shall not require special ventilation. The battery shall consist of one or more battery banks with the number of cells required to meet the requirements of the rest of these specifications.
2. Battery Design Life: five years
3. Run time operation of the UPS shall be accomplished using batteries mounted within the UPS enclosure and supplemented as required with an external battery enclosure to provide the battery runtime specified.

### L. EXTERNAL MAINTENANCE BYPASS

1. Each UPS shall be provided with a "two-position" external bypass switch system to permits the UPS to be removed for repair or maintenance without causing power disruption to the connected power loads. The external bypass switch shall be snap-action type with switching speed approximately 10ms or less independent of operator action. External bypass switch positions shall be labeled UPS and UTILITY.
2. For UPS units up to and including 3 KVA, furnish Liebert MicroPOD, Eaton PowerWare HotSwap MBP, or equal.
3. Substitution of standalone switches, such as Electros witch series 103 snap action switch (or equal), along with custom plugs, receptacles, and appropriate wiring to achieve the specified functionality is acceptable.
4. For UPS units above 3 KVA, substitute standard manufacturers Maintenance Bypass switch offering or standalone switches as indicated above.
5. Provide a dry contact to indicate when bypass switch is in "Maintenance" position. Contact shall be rated for 250VAC @ 5A or 30VDC @ 5A.

### M. ENCLOSURES

1. All UPS equipment shall be housed in a free standing NEMA 1 enclosure(s). The enclosures shall line up and match in style and appearance.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Install and connect the equipment in accordance with the manufacturer's instructions.



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- B. Remove temporary lifting angles, lugs and shipping braces.
- C. Touch up damaged paint finishes.

### 3.02 FACTORY TESTING

- A. Prior to shipment, the complete UPS system shall undergo the manufacturer's standard factory test.

### 3.03 FIELD TESTING

- A. Perform the following minimum test and checks:
  - 1. Verify that all connections are completed in accordance with shop drawings.
  - 2. Verify supply voltage and phase sequence are correct.
  - 3. Check mechanical interlocks for proper operation.
  - 4. Test ground connections for continuity and resistance.
  - 5. Check control circuit interlocking and continuity.
- B. Submit the test plan for review and approval.
- C. For UPSs rated 3-6kVA, the manufacturer's field service technician shall perform startup and adjustment of the UPS in accordance with the manufacturer's written instructions. Submit a copy of the field report containing verification of all startup tests and adjustments performed.
- D. The Contractor shall include testing of battery runtime under full load with loss of AC power.
- E. Perform all additional tests required by Section 16950 Electrical Acceptance Testing.
- F. In the event of an equipment fault, notify the Engineer immediately. After the cause of the fault has been identified and corrected, a joint inspection of the equipment shall be conducted by the Contractor, the Construction Administrator and the equipment manufacturer's factory service technician. Repair or replace the equipment as directed by the Construction Administrator.

### 3.04 ADJUSTMENT

- A. Make all UPS adjustments necessary for manual and automatic operation of the entire system.

### 3.05 CLEANING

- A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint free rags. Do not use compressed air.

### 3.06 TRAINING

- A. Provide training of staff in accordance with Section 01758 and Section 13303.

END OF SECTION

## **SECTION 14443**

### **MOTOR CONTROL CENTERS**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. Section includes motor control centers.
- B. Related Sections:
  - 1. Grounding and Bonding.
  - 2. Electrical Identification.
- C. Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars for each phase, [neutral,] and ground; electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time and current curves of equipment and components.
- D. Product Data: Submit electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of equipment and components.
- E. Test Reports: Indicate field test and inspection procedures and test results.

##### **1.2 CLOSEOUT SUBMITTALS**

- A. Project Record Documents: Record actual locations, configurations, and ratings of motor control centers and major components.
- B. Operation and Maintenance Data: Submit replacement parts list for controllers.

##### **1.3 QUALIFICATIONS**

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

#### **PART 2 - PRODUCTS**

##### **2.01 GENERAL**

The Contractor shall supply and install the motor control center(s) as shown on the Drawings and as herein specified.

Motor control center shall consist of enclosed cabinet type structure with components as specified hereinafter, free standing on channel front sills with sections bolted together to make up the center. Motor control center shall be of Form 2 standard as per the IEC relevant regulations unless otherwise indicated.

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Enclosures for the motor control center shall be general purpose gasketed type to IP55 unless otherwise indicated on the Drawings.

Incoming power feeder shall be cable entering at the top or bottom as applicable and shall terminate on main lugs or main protective device in accordance with the Drawings.

Ample space shall be provided for system control and operation sequence devices, etc. (especially Direct Digital Control (DDC)).

Where motor control centers are controlled/monitored by Building Management System (BMS), reference shall be made to BMS narratives and specifications.

### 2.02 STARTER UNIT COMPONENTS

The starter units shall be of the combination type consisting of components as shown on the Drawings.

The motor horsepower/KW indicated on the Drawings may not be the same as those supplied. If larger motors are supplied, components, cable and conduits of larger capacity may be necessary and if so they shall be provided.

Starter units shall be provided with 2 pilot lights for tripping and running conditions.

### 2.03 MOTOR STARTERS

Motor Starters shall be built and sized in accordance with IEC Standard 158-1, BS 5424 and IEC 292-1&2, or approved equal. Starters shall be non-reversing, magnetic type unless otherwise indicated or specified.

All starters shall be provided with thermal cutout devices in each phase calibrated for close protection of the motors against overloads. These devices shall trip the starters in case of overload and shall not allow it to be reset except manually. The thermal overload relays shall be adjustable from 90 to 110 percent of nominal rating. A single calibration shall adjust all three legs. The overload relay shall be ambient compensated.

The starter shall be provided with auxiliary contacts for the connection of signaling, interlocking and other circuits as required for the controls.

Unless otherwise indicated, all starters shall be provided with START-STOP pushbuttons, and RED and GREEN pilot lights, all located on the starter front cover. An overload reset button shall be provided inside the cover. Pushbuttons shall be momentary contact or maintained type as applicable to the function of control.

Starter shall have horsepower ratings at least equal to ratings of motors they serve.

Voltage of control circuit shall not exceed 220 volts for starters in motor control centers or panels. Individually mounted starters or combination starters may have their control voltage on 380-415 volts provided local regulations or local inspectors do not forbid the use of same. The Contractor when utilizing such voltage for control shall provide a clear warning of existence of such voltage within the station. If 220 volts are required by the local regulations or local inspectors, a neutral conductor shall be brought within the feeder of the starter of approved cross section, at no extra charge.

Starter shall be electrically held in, providing inherent under voltage release.

Starter when not part of a motor control center and are located outdoors shall be encased in an IP 55 enclosure, unless otherwise indicated.

#### A. Direct on line (DOL) Starters

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DOL starters for voltages up to and including 1000V a.c. shall comply with IEC 947. They shall be rated for intermittent periodic duty or intermittent duty class 0.3 and comply with the requirements of utilization category AC-3.

### B. Automatic Star-Delta (ASD) Starters

In all types of star-delta starters the correct phase relationship between the star and delta connections to minimize disturbance on changeover shall be maintained. For example, if the supply phase sequence is L1, L2, L3 and the star point is S then connections shall be as follows:-

	Winding 1 beginning/end		Winding 2 beginning/end		Winding 3	
Connection In STAR	L1	S	L2	S	L3	S
Connection In DELTA	L1	L3	L2	L1	L3	L2

In all star-delta starters the star and delta contactors shall be electrically and mechanically interlocked so that they cannot close or be closed at the same time.

Where overload relays are connected in the phase circuit, the overload relay scales shall be clearly marked to show whether they represent line current or whether the scale must be multiplied by 1.7 to represent line current.

### C. Open Transition and Closed Transition Start-Delta Starters

Automatic changeover timers shall be adjustable from one second up to at least 20 seconds but the transition from star to delta windings shall be achieved without any intentional delay. Closed transition timers shall have tamper-proof factory-set adjustment.

Closed transition star-delta starters shall be arranged for Wauchope connection. The grid resistors shall be rated for 12 seconds in any 90 seconds, for a 260 deg.C rise from a 40 deg.C ambient temperature. Cables connecting onto the grid resistors shall be heat resisting type suitable for the above temperature rise.

Resistance banks shall be housed in separate sections of the control panel or starter.

### D. Auto-transformer Starters

Shall comply with BS EN 60947-4.1 (1992). They shall be rated for intermittent duty Class 0.3 and shall comply with the requirements of utilization category AC-3. The starters shall be arranged for closed transition connection. The transformer shall, unless otherwise specified, have tapings of 65%, 70% and 75% of line voltage.

### E. Starters for Dual-Wound and Pole-Change Motors

Shall be electrically and mechanically interlocked so that it is impossible for both high and low speed contactors to close or be closed at the same time. The parts of the composite starter shall comply with the relevant specification for individual starters. Adjustable timers shall be fitted into the control circuit so that there is a time delay between switching off the high speed contactor and switching on the low speed contactor. When high speed is selected the motor shall run in low speed for a preset time before changing to high speed.

### F. Soft-Start/Stop Starters

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Soft start/stop starters shall be supplied as a unit with an enclosure suitable for panel mounting.

Starters shall be rated for 400V a.c., 50 Hz supply an a temperature operating range of 0 to 50 deg.C. Noise and impulse immunity shall be to ANSI C37-90A, IEC 225-4, IEE 472 (1974) and SEN 361503.

Soft start shall be via a range of switch selectable ramp times of between 0.5 and 60 seconds with a ramp voltage which increases linearly with time.

Soft stop shall be via a range of switch selectable ramp times of between 1 to 120 seconds.

The control circuit shall incorporate a remote emergency stop facility. This function shall override the normal 'soft stop' of the starter.

Filters shall be provided at the inlet and outlet of such devices.

The harmonic current spectrum of each soft-start/stop starter shall be provided by the manufacturer for the calculation and provision of suitable filtration at the electrical switchboard.

A contactor shall be provided to isolate the soft start/stop unit when the motor is not required to run. The contactor shall be arranged to switch 'off-load'.

The maximum starter current shall be 2.0 times full load.

The control panel manufacturer shall calculate the maximum heat dissipation from all soft-start devices and incorporate adequate ventilation methods to ensure that the internal temperature within the control does not exceed 50 deg.C.

### G. Frequency Drives (Inverters)

Frequency inverter drives shall be of the ABB SAMI range type or alternative, approved by the Engineer.

The frequency drive shall employ pulse width modulation (PWM) using thyristor or transistor switches.

The rating of the frequency drive shall be sufficient for the continuous maximum rating of the motor and not its running load.

The frequency drive unit shall have an efficiency in excess of 90%.

Facilities shall be provided to allow the connection of an emergency Stop Push Button to ensure effective direct stopping of the drive if dangerous situations arise. The means provided shall include direct connection to an air-break, e.g. a contactor, arranged such that its opening on-load:-

- a) Does not inhibit any in-built deceleration provided by the variable speed controller.
- b) Does not produce additional safety hazards
- c) And does not cause damage to the controller.

Such contactors must be IEC 947 with utilization category AC-3. The frequency drive shall be capable of switching on to a motor already rotating in either direction.

If the mains cable distance between the motor control panel (MCP) and the motor exceeds 30 meters the inverter shall be located adjacent to the motor, otherwise the inverter shall be housed within the MCP.

### **Inverter Technical Features**

The input to the frequency drive shall be of an uncontrolled bridge rectifier type, to limit harmonic distortion.

The speed shall be smoothly adjustable, and controlled by one of the following:



Circuit breakers shall be thermal magnetic, molded case bolt-on type furnished where indicated on the Drawings. Breakers shall provide thermal inverse time-limit overload and fixed magnetic instantaneous short-circuit protection and shall be as otherwise specified under "Main and Sub-Main Distribution Boards".

Breakers shall be ambient compensated type with a built in compensator to carry rated load at 50C.

Earth leakage relays shall be provided where so indicated on the drawings and shall be shunt tripped with the relevant protective device.

Circuit breakers shall have frame sizes with short circuit interrupting ratings at least equal to the short circuit bracing of the motor control center busbars.

## 2.06 CURRENT LIMITER BREAKERS

Current limiter breakers shall incorporate a slot motor, providing contact opening and arc extinguishing in less than .25 cycles. These breakers shall provide protection to all downstream circuit breakers at the available short circuit levels.

Breakers shall otherwise be similar to molded case circuit breakers as described hereinbefore.

## 2.07 TERMINAL BLOCKS

Terminal blocks shall be installed and internally connected by the manufacturer, for all internal and external wire number. Each terminal point shall have a large marking area or to be equipped with two marking areas.

In addition, with each group of terminals per unit, a minimum of 20 percent unconnected extra non-load terminals, but not less than one, shall be provided for the Contractor's external connections.

## 2.08 CURRENT, POTENTIAL & CONTROL POWER TRANSFORMERS

Current, potential and control power transformers shall be installed as indicated on the Drawings or as needed. They shall be designed for 600 volt service. They shall have adequate thermal capacity and mechanical strength to match the short circuit capacity of the motor control center.

Potential transformers primaries and secondaries shall be protected by fuses. Primary fuses shall be current limiting.

## 2.09 INSTRUMENTS

Instruments such as ammeters, voltmeters, etc. shall be approximately 9 cm square semi flush mounted, and shall be accurate within one percent of full scale. Scale shall be 250 degrees and selected so that normal voltage or full-load current shall indicate at approximately 70 percent of scale reading.

Test blocks and plugs for testing all instruments and instrument transformers shall be provided.

Instruments shall generally be in accordance with the particular specifications under Sub-Section "Instruments and Metering" of these Specifications.

## 2.10 SELECTOR SWITCHES

Selector switches for use in instrument and control circuits shall be of the rotary type with a rectangular escutcheon. The operating handle shall be of the round knurled or notched type for voltage and current.



## 2.11 FINISH

All steel, other than some interior components which are made corrosion resistant by galvanizing or plating shall be thoroughly cleaned, treated with rust inhibiting primer and baked enamel finished with an approved color.

## 2.12 NAMEPLATES AND INDICATING LAMPS

Nameplates shall be provided on and in the motor control center as specified below. All nameplates shall be fastened in place with corrosion-resistant screws.

The top wiring space and each unit door shall be provided with laminated plastic nameplate engraved white on black background in English and Arabic.

All starter control wiring schematic diagrams shall be provided at the back of the unit doors.

Manufacturer's nameplate on the front of the control center shall be provided. Manufacturer's identification on each draw-out unit shall also be provided.

Indicating lamps shall be of low voltage (6V) type with built in transformer.

Lamp test facility shall be provided on one front panel, to enable verifying the status of indicating lamps.

## 2.13 MISCELLANEOUS

Devices such as Hand-Off-Auto selector switches, automatic electric alternator, etc. shall be provided as specified under other sections.

If the motor control center is for the chilled water pumps, it shall incorporate the following items:

- Operation selector switch, three positions: Manual-Off-Auto. On "manual", the pumps shall be possible to be operated individually out of the system control. On "off", no pump shall be possible to be operated. On "Auto" all duty pumps shall operate in the System when system "ON" pushbutton is pressed.
- Standby/duty selector switch, with number of positions at least equal to the number of pumps. This switch shall select the standby pump (or duty pump in case of 2 pumps only).
- System "Start-Stop" pushbutton.
- Space for sequence controller as described under "General" of this subsection.

## **PART 3 EXECUTION**

### 3.1 EXAMINATION

- A. Verify surfaces are suitable for motor control center installation.

### 3.2 EXISTING WORK

- A. Disconnect and remove abandoned motor control centers.
- B. Maintain access to existing motor control centers and other installations remaining active and requiring access.

- C. Clean and repair existing motor control centers to remain or are to be reinstalled.

### 3.3 INSTALLATION

- A. Tighten accessible bus connections and mechanical fasteners after placing motor control center.
- B. Install fuses in fusible switches.
- C. Select and install heater elements in motor controllers to match installed motor characteristics.
- D. Neatly type label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, voltage rating, and phase rating. Place label in clear plastic holder.

**END OF SECTION**

**SECTION 14441**  
**SWITCHBOARDS - 600 VOLT AND BELOW**

**PART 1 - GENERAL**

**1.01 WORK INCLUDED**

This section specifies the furnishing and installation of low voltage switchboards.

**1.02 REFERENCE STANDARDS**

- I. Jordanian codes
- II. Local Utilities regulations
- III. BS 5486 – (Main Distribution Boards).
- IV. BS 159 & BS 5486 – (Busbars).
- V. BS 5486: Part 12,13 – (Sub-main Distribution Boards).
- VI. BS 5486: Part2 – (Busways).
- VII. BS EN 60439-2 : bus bar trunking.
- VIII. BS EN 60898 – (Miniature Circuit Breakers).
- IX. BS EN 60947-2, BS 3871 – (Moulded Case Circuit Breakers).
- X. BS 4293 : RCCB\ELCB

**1.03 General requirements**

The Contractor shall supply and install the Main Distribution Boards and (MDB) & (EMDB) and sub Main distribution boards (SMDB) as shown on the Drawings and as herein specified. The equipment shall include busbars, circuit breakers and/or fusible switches, and all necessary parts to install a complete distribution board, as shown on the Drawings and as herein specified.

The equipment shall be suitably constructed for safe, proper and reliable operation without undue wear, corrosion, heating or other operating trouble.

The design, form of construction and arrangement details of the equipment shall be as indicated on the drawings and to the approval of the Engineer.

The arrangement of the equipment within the assemblies shall be individually-mounting type in a modular arrangement and shall be such as to afford maximum accessibility to all parts, incoming and outgoing wires and cables.

The MDB shall be completely wired and tested at the factory, ready for installation when received at the site. Bracing shall be provided to prevent distortion in handling and shipping.

MDB shall be rated for a 600 volt duty.

The MDB shall be suitably braced for the short circuit duty shown on the Drawings, at nominal operating voltage.

The enclosure and other steel works of MDB shall pass through a four stage finishing process such as chemical spray, degreasing, iron phosphating and finally give a top coat of polyester powder

electro statically deposited and cured in a high temperature oven to give a strong molecular bonding with the steel. The final colour of the enclosure shall be as per the manufacturer's standard. All steel screws, nuts, bolts, shall be zinc plated and passivated to prevent rusting.

All components of the MDB shall be the product of a single manufacturer .

Structural steel base shall be provided for securing entire MDB to floor.

The design, manufacturer's selection, installation, testing, commissioning, connection and future maintenance of all equipment and materials described in this specification shall comply with the requirements of BSEN 60439-1(1994) , the local Power Supply Authority regulations, the IEE Wiring regulations and the documents referenced in each of these publications.

The Contractor must at an early stage provide the Engineer with all the necessary manufacturer's details and shop drawings concerning MDB to allow him to check the design of the concrete structure, particularly concerning the loads, the overall dimensions and the cable grouting holes.

Main distribution board that are directly fed from transformers of the Local Electrical Authorities shall comply with all the requirements of these Authorities. The Contractor shall modify the specified distribution boards to meet these requirements at no extra cost.

#### **1.04 SUBMITTALS**

- I. **Catalogue** . Submit original catalogues for the switchboard, circuit breakers, branch circuit breakers and instrumentation, selected items must be marked clearly.
- II. **Dimensional Drawings**. Submit dimensional drawings of the switchboard, including top and bottom views showing entry and exit space for conduits and bus ways, front and side elevations showing arrangement of all devices and also include dimensional data on all buses including material type and capacity of the buses.
- III. **Electrical Information**. Submit single line diagrams for equipment being provided. Also submit information on all protective devices including type ratings and settings of all trips provided to include ground fault relay settings.
- IV. **Coordination Curves**. Manufacturer shall provide coordination curves on log-log paper for the main protective device and for the largest branch circuit devices. These curves shall also show the ground fault protective relay.

## **PART 2 - PRODUCTS**

### **2.01 DESCRIPTION**

#### **Construction of the panel**

Unless otherwise indicated, the panel shall be of the indoor gasketed type of size, rating and arrangement as indicated on the Drawings. The complete MDB shall be ground mounting type with matching cases to form continuous internal structure.

MDB shall consist of a completely enclosed self supporting metal structure, containing circuit protective devices and all other associated equipment as indicated on the Drawings and/or specified under other Clauses.

MDB shall consist of the required number of formed and welded sheet steel enclosures required to mount circuit protective devices and other equipment.

Bolted frames shall be provided at the rear to support and house copper busbars, cables and other accessories.

Front, side and top plates shall be steel, removable and not less than 2 mm thickness.

All fastenings between structural members shall be bolted, not welded to provide flexibility during installation.

Removable panels shall be provided at the front of each vertical section.

The arrangement shall permit cables to enter from bottom and top of the enclosure and connect to their respective terminals without interference. MDB shall be provided with cable racks and bolting down holes.

A modular individual mounting arrangement (in Form as indicated on the drawings) shall be used and the internal separations shall be carried out using rigid barriers or partitions.

Structure and buses shall be arranged to permit future sections to be added. Suitable cover plate must be provided for temporary protection.

MDB shall be vermin and rodent proof. Protection shall be to IP41 as a minimum requirement unless otherwise indicated on the Drawings.

#### **Busbars**

Main insulated busbar with a ratings as shown on the Drawings shall be provided across the top of each structure. Each structure shall also be complete with vertical copper buses to distribute incoming power to each outgoing protective device in the structure. The distribution board bussing shall be plated and sleeved as per authorities requirements and of sufficient cross-sectional area to continuously conduct rated current with a maximum average temperature rise of 20 degree C above an ambient temperature of 50 degree C.

Each phase and neutral busbar shall be tin plated and shall consist of hard drawn, high conductivity copper of uniform rectangular cross section throughout to BS 1433.

All bus connections shall be bolted and clamp type terminals provided for cables.

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All bus bars and busbar connections shall be accessible for inspection and maintenance only, after the removal of covers secured by bolts and studs. Such covers shall be identified externally by Engraved laminated labels bearing the inscription; "Busbars - Danger 380 volts" in 30 mm high black lettering on yellow backing round.

Neutral shall be full size, unless otherwise indicated.

No Diversity shall be used in Bus Bar dropper sizing.

Earthing bus shall be sized in accordance with the BS 7430 for prospective short circuit.

Grounding (earthing) bus shall extend through the entire length of MDB & E MDB.

Main Distribution Board that is fed directly from the transformer shall have the following additional features:

- a) Neutral busbar shall be provided with a removable solid bar link for testing purposes.
- b) A separate bonding strap shall be connected from the neutral bus to the main distribution board frame. This bonding strap shall be located on the line side of the removable neutral link maintaining a service ground to the main distribution board frame when the test link is removed.
- c) Any additional feature as per the Electrical Authorities requirements.

### **Labels**

All enclosures containing functional units shall be clearly labeled with a circuit unit reference and current rating in English and Arabic. Every functional unit shall be labeled separately from all others. External labels shall have letters not less than 5 mm in height and internal labels not less than 3 mm. The letters shall be black in colour on white background.

All covers/doors not fitted with interlock switched disconnectors enclosing enshrouded live equipment, shall be fitted with warning labels inscribed "Danger-Isolate before Opening" in English and Arabic.

Warning labels shall have black letters on bright yellow background. Whenever possible, letters shall be not less than 30 mm in height. On small covers and doors 20 mm or 10 mm high letters shall be used.

All terminal blocks shall be labeled relative to respective functional unit. Every control and metering device, switch, pushbutton, indicator lamp, etc.. shall be labeled to indicate its purpose.

Main identification labels shall be provided on MDB together with its rating plate.

Fixed and withdraw able portions of equipment, including fixed and plug in devices shall be labeled with both with draw able and fixed part.

### **Selector Switch/Push Buttons/Indicator Lamp**

Selector switches shall be of the rotary type with lever or key operated actuators as specified in the schedules. Push button shall be of the flush type with colours in accordance with BSEN 60043:1993.

Pushbuttons for emergency stop purpose shall be of mushroom head type, with twist to release action or key reset facility as specified.

Contact blocks shall have double break silver plated contacts in NO or NC configuration rated at not less than 5A resistive at 230V, 50Hz.

Indicating lamps shall be of the flush type, 22 mm diameter, with removable coloured lenses to permit replacement of lamps from the front. Colours shall be in accordance with BS 4094.

Indicating lamps on control circuits shall be equipped with completely sealed dual wound safety isolating transformers. Lamp test facility shall be provided.

### **Testing and Commissioning**

The main distribution board MDB shall be tested at factory in accordance with the requirements of BSEN 60439-1 and the associated standards.

Work tests shall include inspection of all components, wiring and a complete electrical functioning test.

Protection relays shall be tested by primary current injection method, with currents equal to overload, short circuit and earth fault conditions.

After completion of installation of the switchgear assemblies on site, they shall be subjected to the routine tests as defined in BSEN 60439-1.

All functional units shall be checked for correct mechanical operation.

Following the satisfactory conclusion of inspection and tests both at factory and on site, each MDB shall be duly commissioned and left in full working order. The commissioning process shall be deemed to include the following:

1. Energizing of functional device circuit and equipment which have been inspected, megger tested, found satisfactory and capable of being energized with complete safety.
2. Starting up of all electrically powered plant and equipment including those supplied and installed under other sections of the contract.
3. Verification of the performance of each switchgear MDB relative to all such plants and equipment by carrying out functional tests, where required and making necessary adjustments for optimum performance.
4. Testing interlock options in all possible combinations and operations of control system.

### **Circuit Breakers**

Circuit breakers shall be as per the local utility recommendations.

Circuit breakers shall be moulded case type, or Air circuit breakers as indicated on drawings totally front accessible and front connectable. The breakers shall be mounted in the distribution board to permit installation, maintenance and testing without reaching over any live side bussing.

Circuit breakers shall comply with IEC 947-2 (EN 60947-2) and short circuit category ICS.

Test certificate from independent laboratory to certify that the MCCB's comply with the IEC-947-2, (EN 60947-2) test sequence -2 shall be submitted when required by Engineer.

All line and load side connections shall be individual to each breaker. No common mounting of electrical bus connectors will be acceptable. Line side breaker connections shall be bolt-on type. Breaker connections requiring leaf and coil springs which could loosen or fly apart during a fault are not acceptable.

Frame shall be constructed from molded moldarta and/or glass polyester material.

The operating mechanism shall be toggle type quick-make, quick-break, trip-free, with three different positions for ON, OFF & TRIP.

Circuit breakers shall incorporate an arc-extinguishing compartment such that when the contacts are opened, the arc drawn shall induce a magnetic field in the grids, which in turn, shall draw the arc from the contacts and into the grids, thus splitting the arc into smaller arcs and extinguish very rapidly.

The trip element shall be a bi-metal for overload and an electromagnet for short circuit.

Moulded Case Circuit Breakers (MCCB) breakers shall be electronic type with adjustable, setting for overload, & and short circuit. The breaker should have a facility to test the tripping circuit of the MCCB by inducing an electrical pulse from portable unit.

Breakers shall be manually operated with store energy spring load.

Breakers shall be ambient compensated type with a built-in compensator to carry rated load at 50 degrees centigrade.

Breakers shall have 415/380 volt duty rating, and a minimum symmetrical short circuit interrupting rating equal to 50 KA for main distribution boards associated with 1500 KVA transformers and 40 KA for MDB's with 1000 KVA transformers.

Each breaker shall be supplied with an externally operable mechanical means to trip the circuit breaker.

Key interlocks for circuit breakers where indicated shall incorporate a plunger that blocks the breaker in the open position. Key removal shall be possible in such a way to achieve the desired interlocking system.

Where required, breakers shall be suitable for bus way connection.

Main breaker shall be insulated case type provided with interchangeable trip units, current transformers, flux-transfer short trip and solid state circuiting.

### **Air Circuit Breakers**

Air circuit breakers shall be totally withdraw able type completely self-contained in an enclosed housing to be mounted in a switchboard cubicle without additional screening. It shall occupy a complete section, completely segregated from all other parts of the switchboard. Vent holes shall be provided in the side of the circuit breaker housing to provide thermal ventilation and also to permit easy air flow through the arc chutes when interrupting a short circuit. The circuit breaker shall be installed in an enclosure greater than twice the breaker volume.



Air circuit breakers shall be equipped with solid state microprocessor based protection unit.

The protection unit shall not require any external power supply. It shall have adjustable long time protection for overload, adjustable instantaneous short circuit protection and earth fault protection for the incoming air circuit breakers. The outgoing air circuit breakers shall have, adjustable long time protection for overload and adjustable instantaneous short circuit protection only. The protection unit shall have magnetic trip indicator and shall be adjustable for ambient temperature upto 70 degree C.

Operating mechanism shall be of the trip free spring assisted hand closing type. It shall include a slow close feature for checking contact operation and adjustment. A flag type indicator shall indicate the ON or OFF position.

Air circuit breakers shall be of the triple pole or four-pole as specified in the schedules or as indicated on the drawings. Where four pole breakers are called for, one pole shall be a full sized switched neutral.

The air circuit breaker shall be closed and opened by a stored energy spring charged operated, mechanism. The operating mechanism shall be designed in such away that the excess energy at the end of a closing cycle is used to partially recharge the closing spring.

Also the opening springs shall be automatically charged during the closing operation.

The air circuit breaker shall in addition have adjustable short time delay in both current and time directions, and adjustable instantaneous trip in the current direction.

All contacts subject to arcing shall be tipped with arc resistant material and shall require minimum maintenance after short circuit interruption. The main contacts shall be silver faced to ensure complete reliability in service under onerous current loading or ambient conditions.

The arc chutes shall be of special design employing steel splitter plates. The plates shall be arranged so that the arc is rapidly de-ionized while it is contained within the chute structure and the plate spacing shall be such that back pressure is minimized. The complete chute MDB shall be easily removed for routine inspection of the chute and contacts.

Isolating contacts shall be multi-finger spring loaded type which shall be silver plated and shall require no attention.

A front operated racking mechanism shall cause withdrawal of breaker. Access shall be via a lower cover. Safety shutters of insulation material shall be provided to prevent access to live connections in the inspection position or when the breaker is completely withdrawn.

Interlocks shall be provided to prevent being isolated unless it is in the OFF position and also to prevent the breaker being racked into the service position unless it is in OFF position. Interlocks shall also prevent the breaker being accidentally pulled completely off the guide rail and prevent the independent manual operated breaker being "slow closed" in the service position. Provision shall be made for padlocking the safety shutters when the breaker is completely withdrawn.

Locks shall be provided to prevent access to the time lag dashpots and racking mechanism, preventing unauthorized adjustment of the trip setting, also enabling the circuit breaker to be locked in the isolated position thus disconnecting the supply.

Breakers shall be ambient compensated type with a built in compensator to carry rated load at 50o C.

Air circuit breakers shall conform to IEC-947-2 (EN 60947-2).

An earth terminal shall be provided at the rear of the withdrawable breaker housing connected to a plug and socket contact, to provide an earth connection to the moving breaker portion. Contacts shall be maintained in the breaker isolated portion.

Short circuit performance shall comply with IEC-947-2 (EN 60947-2), including make-break tests at up to 50 KA rms and 100 KA peak with minimum recovery voltages of 550 volts.

Mechanical endurance shall ensure over 30,000 operations with only minor maintenance.

A non reset table number of operation counter shall be provided.

Suitable cable glands shall be provided for the support of the incoming supply cables.

### **Branch Circuit Breakers for Chillers**

Breakers protecting chillers shall also incorporate the following protections:

- Phase failure relay
- Reverse phase relay
- Under voltage relay
- Over current relay

All these relays shall be connected to the shunt trip circuit of the breaker.

## **PART 3 - EXECUTION**

### **3.01 PROTECTION OF SWITCHBOARD**

- I. See Section 16010, paragraph 3.1 - Electrical General Provisions.

### **3.02 FOUNDATION PAD**

- I. Provide a foundation pad for the switchboard as specified in Section 16010, Electrical General Provisions. Secure the switchboard to the pad as recommended by the manufacturer. Include openings for bottom feeds to the switchboard which are compatible with the equipment provided.

### **3.03 EQUIPMENT INSTALLATION**

- I. Field Connections. Make field connections of buses between switchboard sections with splice bus and hardware provided by the switchboard manufacturer.
- II. Equipment Settings. Properly set adjustable current and voltage settings as noted on shop drawing submittals. Effectively accomplish grounding and bonding.
- III. Restoration. Restore all damaged surfaces to factory finish.
- IV. Inspection. Thoroughly inspect the switchboard for items such as loose connections and presence of foreign materials and remedy prior to energizing the switchboard. All bolted connections shall be torqued to the manufacturer's recommendations.
- V. Double Lugging. Double lugging on one protected device to feed two separate loads will not be permitted.

**3.04 TESTING**

- I. After installation and before acceptance by the Owner, the Contractor shall perform test which will include the polarity of the current sensors and give an indication of satisfactory operation of voltmeters, ammeters and their selector switches.
- II. The Contractor shall notify the Engineer of this test date 2 days in advance so the tests can be properly witnessed.

END OF SECTION

**SECTION 14442**  
**PANEL BOARDS - DISTRIBUTION & BRANCH CIRCUIT**

**PART 1 - GENERAL**

**1.01 WORK INCLUDED**

This section specifies the furnishing and installation of distribution and branch circuit panel boards.

**1.02 REFERENCE STANDARDS**

- I. Jordanian codes
- II. Local Utilities regulations
- III. BS EN 60439 - Electric Panel boards.
- IV. IEC 947-2 Molded Case Circuit Break
- V. IEC 439-2 Buses.

**1.03 APPLICABLE PROVISIONS**

Refer to Section 16010, Electrical General Provisions.

**PART 2 – PRODUCTS**

**General**

The Contractor shall supply and install the distribution boards (DB, EDB) as indicated in the Schedules, where shown on the Drawings, and as herein specified. They shall include bus assembly, cabinet and front, circuit breakers and all necessary parts to install complete distribution boards.

Distribution boards shall be factory assembled.

Distribution boards shall be of a dead-front safety type, equipped with protective devices as shown on the Schedules.

Distribution boards shall have 400 V volt duty rating, with other ratings as shown on the Drawings.

Distribution boards circuit numbering shall be such that, starting at the top, odd number shall be used in sequence down the left-hand side and even numbers shall be used in sequence down the right-hand side.

Distribution boards shall conform to BSEN 60439-1:1994.

Distribution boards shall incorporate miniature circuit breakers of tripping characteristics B,C or D for lighting, miscellaneous power or motor loads as necessary complete as specified and as shown on the drawings and to the approval of Engineer.

### **Cabinets and Fronts**

The distribution board bus assembly shall be enclosed in a galvanized sheet steel cabinet. Cabinet shall be of sufficient size to provide a minimum gutter space of 10 cm on all sides. The thickness of the sheet steel shall be minimum 1.2 mm.

Fronts shall include doors and have flush, brushed stainless steel cylinder tumbler-type locks with catches and spring loaded door pulls. The flush lock shall not protrude beyond the front of the door. All distribution board locks shall be keyed alike. Fronts shall have adjustable indicating trim clamps which shall be completely concealed when the doors are closed. Fronts shall have approved directories with name of panel, number of phases, wires and voltage written on them.

Doors shall be mounted by completely concealed steel hinges. Fronts shall not be removable with door in the locked position. A circuit directory card shall provide a space at least 0.5 cm high x 7 cm long or equivalent for each circuit.

The directory card shall be typed to identify the load fed by each circuit.

Fronts shall be of code gauge, full finished steel with rust-inhibiting primer and baked enamel finish. Color shall be gray to ANSI No. 61, BS 381 C or approved equal.

Joints shall be welded, galvanized and reinforced where necessary and galvanized after fabrication.

### **Distribution Board Bus Assembly**

Bus for connections to the branch circuit breakers shall be the "Distributed Phase" or "Phase Sequence" Type.

Three-phase, four-wire bussing shall be such that any three adjacent single-pole breakers are individually connected to each of the three different phases in such a manner that two or three pole breakers can be installed at any location. All current carrying parts of the bus assembly shall be plated.

Main and neutral buses shall be minimum 98 percent purity, rectangular copper bars, provided with bolted-type lugs as necessary.

Buses of miniature circuit breaker distribution boards shall be suitably braced for a minimum short circuit duty equal to 10,000 Amps unless otherwise indicated.

Buses shall be rigidly supported and insulated and be so designed that branch circuits can be removed without disturbing adjacent units or changed without additional machining, drilling or tapping.

Necessary bussing, drilling and blank plates shall be provided for installation of future circuits when so indicated in the Schedules on the Drawings.

All screws and bolts used for making copper connections shall be equipped with lock washers. Riveted connections will not be acceptable.

## Wadi Mousa Central City Development

Mains shall be equipped with solder less pressure indent type connectors and have means to prevent swiveling of connector.

Neutral terminal strip shall be full size and shall incorporate one neutral terminal for each single pole and neutral way.

Aluminum shall not be used for any interior parts of the distribution board.

Back pan or mounting on which buses and branches are mounted shall be rigid to properly support the component parts.

Reinforcing of back pan shall be by flanging or addition of angle iron.

Buses, connectors, and terminals shall be silver plated to a minimum thickness of 0.1 mm.

### **Split Bus Distribution Boards**

Split bus distribution board shall incorporate a main switch or circuit breaker for the entire distribution board and two or more sub-main earth leakage circuit breakers that shall protect each section of the distribution board circuits against earth leakage.

For the wiring of circuits consisting of wire sizes 10 mm<sup>2</sup> and larger shall be of the bolted pressure type, with a pre insulated sleeve.

Connectors shall be manufactured from high conductivity copper, electro tin-plated.

### **Earthing**

An acceptable terminal bar for equipment earthing conductors shall be provided with a minimum number of cable terminations equal to the single pole number of ways of the distribution board.

A cable connection shall be made from the earth bar to the cable gland of the incoming feeder as applicable.

Cabinet shall be provided with an earth connector welded to it.

### **Circuit Breakers**

Main breaker shall be as per the local utility recommendations.

All circuit breakers shall have trip settings, and number of poles, as indicated on the Drawings and have their ampere trip rating clearly marked and visible.

Breakers shall have quick-make, quick-break, toggle mechanism and shall provide positive trip free operation on abnormal overloads. Stationary and movable contacts shall be adequately protected with effective and rapid arc interruption. Each pole of the breaker shall be equipped with an inverse time delay thermal over current trip element and magnetic instantaneous over current trip elements for common tripping of all poles for multiple breakers. Multiple pole breakers shall have a single handle mechanism. Automatic tripping shall be indicated by the breaker handle assuming a clearly distinctive position from the manual ON and OFF position.

Circuit breakers shall have minimum RMS symmetrical interrupting capacities equal to 6000 Amps at 380 V for miniature circuit breakers and capacities equal to the values indicated in the drawings for moulded case circuit breakers but shall in no case be less than the busbar short circuit bracing of the distribution board.

Moulded case circuit breakers shall have frame sizes equal to or greater than their trip ratings unless otherwise indicated and shall be suitable for operation at an ambient temperature of 50 degree C.

### **Earth Leakage Circuit Breakers**

Each leakage circuit breakers shall be current operated type providing protection against overloads, short circuit, and low level earth faults of 30 mA, 100 mA or 300 mA as applicable or as shown on the drawings.

It shall fit in standard distribution boards.

A push-to-test mechanism shall be provided to ensure proper operation.

Enclosure shall be glass reinforced.

Breaker shall have 6000A interrupting capacity unless otherwise indicated.

Breaker shall otherwise be similar to miniature circuit breakers.

### **Distribution Board Installation**

Distribution board shall be aligned, leveled and securely fastened to the building surface mounted application or recessed in the wall flush mounted distribution board.

Connecting conduits shall not be used to support the distribution board.

All unused openings in distribution board cabinets shall be properly closed.

Distribution board interiors shall not be installed in cabinets until all conduit connections to the cabinet have been completed.

Trim for flush mounted cabinets shall be installed in plaster frame, flush with finished wall.

Trim shall be installed plumb and square to finish painting.

Concealed surfaces of cabinets shall be given on site a heavy application of emulsified asphalt prior to installation.

### **Shop Drawings**

The Contractor shall submit shop drawings for the switchboards including schematic diagrams with all protective devices, control, instruments and instrument transformers details, dimensions of the assembly, etc. A copy of these shop drawings shall also be submitted to the local power authorities for approval. Any modification required by the Engineer or the local power authorities

to allow the equipment to comply with the codes, standards and specifications called of hereinbefore shall be carried out without additional charges.

### **PART 3 - EXECUTION**

#### **3.01           INSTALLATION**

I.           Install panel boards in the locations as shown and as recommended in BS & IEC. These panels should be recessed in walls with decorative Cover.

#### **3.02           MOUNTING HEIGHT**

I.           Install the panel boards such that the center of the switch or circuit breaker in the highest position will not be more than 2 meters above the floor or working platform.

END OF SECTION



**SECTION 14500**  
**Lighting Fixtures, Lamps**

**PART 1 - GENERAL**

**1.01 SUMMARY**

This section specifies the furnishing and installation of lighting fixtures complete with lamps and other accessories.

**1.02 REFERENCE STANDARDS**

Jordanian codes

BS EN 60920 & BS EN 60921- Fluorescent-Lamp Ballasts.

BS EN 60922 & BS EN 60923 - High-Intensity-Discharge Lamp Ballasts - Sodium Lamps.

BS EN 60922 - High-Intensity-Discharge Lamp Ballasts - Mercury Lamps.

BS 1853 - Fluorescent Lighting Fixtures.

BS 3677 - High-Intensity-Discharge Lighting Fixtures – Mercury Lamps.

BS EN 60662 - High-Intensity-Discharge Lighting Fixtures – Sodium Lamps.

IEC-1167 - High-Intensity-Discharge Lighting Fixtures – Metal Halide Lamps.

British Code (BS)

**1.03 GENERAL REQUIREMENTS**

1. Pendant fixtures within the same room of area shall be installed plumb and at a uniform height from the finished floor. Adjustment of height shall be made during installation.
2. Flush mounted recessed fixtures shall be installed so as to completely eliminate light leakage within the fixture and between the fixture and adjacent finished surface.
3. Fixtures located on the exterior shall be installed with non-ferrous metal screws finished to match the fixtures.
4. Luminaries fitted with high frequency or electronic control gear shall be disconnected before the circuit is tested for insulation resistance.
5. Unless otherwise stated all luminaries designed for internal use shall be constructed to IP 20 and be Class 1. For IP-Rating refer to lighting fixture schedule in contract drawings.

## **PART 2 PRODUCTS**

### **General**

The Contractor shall be responsible to supply the specified lighting fixtures as indicated on the drawings. Fixtures shall bear manufacturer's name and the factory inspection label.

Fixtures shall be completely wired and constructed to comply with IEC Publication 598-1 598-2 and BSEN 60598-1: 1993 unless otherwise specified..

All luminaires supplied by the contractor shall be photometrically tested to BS 5225: Part 1.

Relamping the fixture shall be possible without having to remove the fixture from its place.

Certain fixtures may be shown in provisional position. They shall be exactly located as soon as the final layout of equipment is known.

Any plastics used in the luminaire shall be light and U.V. stable and shall be suitable for their application.

All sheet steel components shall be suitably pre-treated and electrostatically spray-painted using acrylic polyester or epoxy powder paint.

Fixtures that are used under canopy or directly exposed to weather shall be considered as being outdoor type.

### **Construction - General**

Indoor fixtures shall be constructed of 0.7 mm thick steel minimum. If other metals are used they shall be of the required thickness to have at least the same mechanical strength.

Cast portions of fixtures shall be not less than 1.5 mm thick.

Metal parts of the fixtures shall be completely free from burrs and tool marks. Solder shall not be used as a mechanical fastening device on any part of the fixture.

Fixtures with visible frame shall have concealed hinges and catches.

Recessed fixture shall be constructed so as to fit into ceiling without distorting either the fixture or the ceiling. Plaster rings shall be provided for plaster ceilings. The Contractor shall coordinate the dimensions with the false ceiling tile or panel dimensions.

Outdoor fixtures (under canopy or directly exposed to the weather) shall be constructed of an appropriate weather resistant material including gaskets to prevent entrance of water into wiring.

External fixtures shall be constructed to minimum classification of IP44 and be class unless otherwise stated.

Fixtures with hinged diffuser doors shall be provided with spring clips or other retaining devices to prevent the diffuser from moving.

Bathroom fixtures shall be marked as being suitable for damp locations and shall be of minimum IP44 degree of protection, class-1. Lampholders of such fixtures shall be provided with a protective shield to prevent contact with the lamp cap.

Fixtures with exposed metal parts shall be provided with a means for connecting an equipment earthing conductor for such fixtures.

Incandescent fixtures shall be equipped with porcelain medium base with nickel-plated shells. Sockets shall be bayonet type for lamps up to and including 150 watts and right hand screw type for lamps 200 watts and above.

Lighting fixtures intended for use as emergency lighting either as self contained or slave type shall be "F" marked when used in or on ceilings consisting of flammable material.

Pendent fixtures and lampholders shall be provided with ball type aligners.

### **Construction - Fluorescent Fixtures**

Fixtures shall be provided with white click-in type lampholders.

Pendent individually mounted fixtures 60 cm and longer shall be provided with twin stem hangers. Stems shall have ball aligners and provision for a minimum of 2.5 cm vertical adjustment.

Diffusers shall be manufactured from one piece non-glued methacrylate.

Mirror system light controlled fixtures shall comprise a metal encased aluminium mirror system with aluminium mirror strips forming a parabolic reflector. Lamps shall be screened in the longitudinal direction by means of matt-white louvre partitions unless otherwise specified on the drawings.

Clear smooth diffusers shall be smooth from outside, finely grained from inside.

Corrosion resistant fixtures shall comprise polyester resin fibre-glass reinforced body, dust and splash-proof.

Damp-resistant fixtures shall comprise polyester resin fiberglass reinforced body, dust and jet-proof.

Luminaires containing compact fluorescent lamps shall be designed to ensure the correct working conditions for the lamp.

All fluorescent luminaires shall be supplied with electronic High frequency ballast and single pulse electronic starters, unless otherwise stated .

Explosion proof fixtures if any shall be suitable for hazardous location specially for paint spray booths, and locations having deposits of readily combustible paint residue. All exposed hardware shall be stainless steel. All exterior material shall be non-sparking.

## **Finish**

All hardware shall be bonderized, cadmium-plated, given a corrosion-resistant phosphate treatment or other approved rust inhibiting prime coat, to provide a rustproof base before application of finish.

Finish shall be baked enamel.

Non-reflecting surfaces such as fixture frames and trims, shall be finished with baked enamel paint, unless otherwise specified. The color of the paint shall be as indicated on the Drawings or as directed later by the Engineer on Site.

Light reflecting surfaces shall be finished with baked white enamel paint having a reflection factor of not less than 85%.

All parts of the reflector shall be completely covered by the finish and free from irregularities.

Unpainted surfaces shall be finished with a clear lacquer except for anodized or "Azac" surfaces.

After finish has been applied and cured, it shall be capable of withstanding a 1 cm radius bend without showing signs of cracking, peeling or loosening from the base metal.

Finish shall be capable of withstanding 72 hours exposure to an ultra-violet RS sun lamp placed 10 cm from the surface without discoloration, hardening, or warping and shall retain the same reflection characteristics after exposure.

## **Wiring**

Wiring within fixture and for connection to the branch circuit wiring up to the outlet box of lighting point shall not be less than 1.5 mm<sup>2</sup>. Insulation shall be silicone rubber, finish shall be glass braid. Suitable for 150 degree centigrade normal service temperature, 300/300 volts. Cable entry to fixture shall be dust sealed.

## **Installation**

Fixtures shall be installed at mounting heights as detailed on the Drawings or as instructed on Site by the Engineer.

Fixtures and/or fixture outlet boxes shall be provided with hangers to adequately support the complete weight of the fixture. Design of hangers and method of fastening, other than shown on the Drawings or, herein specified, shall be submitted to the Engineer for approval.

Pendent fixtures within the same room or area, shall be installed plumb and at a uniform height from the finished floor. Adjustment of height shall be made during installation.

Flush mounted recessed fixtures, shall be installed so as to completely eliminate leakage of light within fixture and between the fixture and adjacent finished surface.

Fixtures mounted on outlet boxes shall be rigidly secured to outlet box. Hickeys or extension pieces shall be installed where required to facilitate proper installation.

Surface mounted fixtures longer than 60 cm shall have one additional point of support besides the outlet box fixture stud when installed individually.

Fixtures located on the exterior of the building shall be installed with non-ferrous metal screws finished to match the fixtures.

Where edison screw lampholders are used, the outer contact must be connected to the neutral conductor.

Fixtures installed in false ceiling shall be connected to the relevant lighting outlet through a flexible cord & ceiling rose, unless otherwise specified under "CONDUITS". Each fixture shall have its corresponding lighting outlet.

### **Lamps - General**

Lamps shall be supplied and installed in all lighting fixtures listed on the Drawings.

Lamps used for temporary lighting services shall not be used in the final lamping of fixture units.

Lamps for permanent installation shall not be placed in the fixtures, until so directed by the Engineer, and this shall be accomplished directly before the building areas are ready for occupancy by the Employer.

### **Lamps - Fluorescent**

Lamps shall be of the normal start energy saving type, unless otherwise indicated.

Lamps shall be krypton filled, in place of the traditional argon fill.

Lamps shall have bi-pin bases and a minimum approximate rated life of 8,000 hours.

Lamps with WHITE colour rendering shall have the colour rendering features similar to 'TL'D colour 84 at 4000K and lamps with WHITE DELUXE colour rendering shall have the colour rendering features of 'TL'D colour 83 at 3000 K. Lamps shall have 96 lm/ watt output minimum based on 36 watt lamps.

Compact fluorescent lamps shall be of the 4-pin type manufactured in accordance with BS 6982.

Compact fluorescent lamps shall be suitable for operating as emergency lighting sources where specified.

Compact fluorescent lamps shall be suitable for operating on standard wire wound and H.F. ballasts.

Where the lamps are used horizontally, they shall be adequately supported along their length.

Lamps shall have WHITE colour rendering unless otherwise indicated.

### **Lamps - Incandescent**

Incandescent lamps shall be inside frosted type, unless otherwise indicated.

Lamps shall have a minimum approximate rated life of 750 hours. Lamps shall have medium base bayonet type for lamps up to 150 watts and right hand screw type for lamps 200 watts and above unless otherwise indicated or approved..

### **Lamps - Halogen**

Halogen lamps shall be either mains-voltage or low voltage type as described in the lighting fixtures schedules in the drawings.

The tubular envelope of the lamp which is made of a special quartz glass shall be resistant to the high temperatures needed for the halogen cycle to function.

Care shall be taken in handling the quartz envelope lamps, where the lamp should not be handled directly.

The lamp shall be cleaned using soft cloth moistened with white spirits.

Luminaires using low voltage tungsten-halogen lamps shall be supplied complete with its own transformers unless otherwise stated. Wire wound transformers shall be rated at 250/11.8 volts and shall comply with IEC742, class I/class II and be insulated to class H of BS 2757.

Transformers shall be protected against overload and short circuiting.

Final connections to luminaires shall be carried out using silicon rubber sheathed cables.

Dimmers for low voltage tungsten-halogen lamps shall be hard wired type suitable for inductive loads.

Transformers used in dimmed circuits shall be down rated as recommended by the manufacturer.

Electronic transformers shall be protected against short circuit and overload. It shall contain a soft start circuit and be self regulating.

Electronic transformers shall comply with IEC 742 and 34C/comex (PK) 8 and 14 with RFI suppression complying with BSEN 55014:1993.

Electronic transformers used in dimmed circuits shall be suitable for dimming. The dimmer shall be compatible with the transformer. When installed in ceiling voids, the transformer shall be capable of subsequent removal either through the fitting aperture or through an access panel.

Lamp holders in dichroic or capsule luminaires shall be easily accessible for relamping.

Where sealed low voltage lamps are used the luminaire shall be designed to cope with the increased temperature.

The integral wiring of dichroic lamps shall cope with the increased temperature.

All dichroic lamps shall be of the captive type.

Capsule low voltage lamps shall not be installed using bare hands. protective glass shall be incorporated in capsule lamps fittings.

Mains voltage tungsten halogen lamps shall be either of the single ended or double ended type as specified in the fixtures schedule. The single-ended lamps shall be of the frosted version unless otherwise specified or directed by the Engineer.

Double envelope and reflector lamps could also be implemented if specified or directed on site.

The design of main voltage luminaires shall insure the withstanding of bulb wall temperature of 250 degree C and a maximum pinch point temperature of 350 degree C.

### **Lamps - Mercury Vapour, and Metal Halide**

Mercury lamps shall be high-pressure mercury-vapour fluorescent lamps, with a quartz discharge tube enclosed in an internally coated ovoid outer bulb.

The quartz discharge tube shall contain a small quantity of mercury and a starting gas.

The average luminous flux after 100 burning hours shall for a 50 W lamp, be 1850 lumens horizontal and 2000 lumens vertical. The number of minutes after which the lamp has reached 80% of its final luminous flux shall not exceed 5 minutes for 50 W lamps, and 4 minutes for higher wattage lamps.

Lamps below 125 W shall be fitted with normal glass and lamps 125 W and above shall be fitted with hard glass.

Metal Halide lamps shall be similar to mercury vapour lamps except that the discharge tube shall contain metal halide compounds and the average luminous output after 100 burning hours for a 375W lamp shall not be less than 30000lm

### **Lamp - High pressure Sodium**

High pressure sodium vapour lamp shall be suitable for outdoor use. It shall include a sintered aluminium oxide discharge tube enclosed in a clear, tubular hard-glass outer bulb.

The average luminous flux after 100 burning hours shall be the following:

For 150 watts: 16000 lumens.

For 250 watts: 27000 lumens.

For 400 watts: 48000 lumens.

For 1000 watts: 130000 lumens.

The number of minutes after which the lamp reaches 90% of its final luminous flux shall be the following: For 150, 250 and 400 watts, 5 minutes.

For 1000 watts, 6 minutes.

The re-ignition time shall not exceed 3 minutes.

The lamp shall be suitable for universal burning position.

The lamp shall be able to operate in both high (+50 deg C) and low (-50 deg C) ambient temperatures.

The lamp shall have a stable operation with supply voltage as low as 200 Volts.

#### **Starters - Fluorescent (Electronic)**

Starters shall be electronic type, enclosed in a polycarbonate box mounted inside the luminaire with the ballast.

Electronic starters shall comply with BS 3772 Part 1.

Starter shall provide immediate ignition (0.5 seconds) of standard fluorescent lamps to comply with BS 3772.

Starters shall have negligible watt loss, and shall be noiseless.

#### **Ballasts - Fluorescent (Electronic)**

All fluorescent ballasts shall be electronic ballasts except fluorescent lighting units used to be dimmed and connected to dimmers, where such ballasts should be dimmable electronic ballasts.

Electronic Ballast shall be solid state high frequency electronic controlled type with no noise nuisance, high operating frequency, 0.95 power factor, instant non-flickering start, automatic switch-off if lamp is defective, no stroboscopic effect and no electrode flickering. All components shall be mounted on a common wiring board, with a sheet metal housing for mechanical protection. It shall require no starter.

Earth leakage current must be below 0.4 mA measured according to IEC-598-1.

Radio frequency interference must be in accordance with EN 55015.

Ballast must be in accordance with IEC 928 (ballast safety) and IEC 929 (ballast performance).

Total harmonic distortion must be below 10% and in accordance with EN 6000-3-2.

#### **Ballasts - fluorescent (Electronic dimmable).**

Electronic controllable fluorescent ballasts shall be dimmable with a dimming range from 5 to 100%.

The ballast shall be noiseless with no buzzing at any light level.

The power factor must not fall below 0.8 at any lighting level and shall be more than 0.95 at full lighting level. The total harmonic distortion must not exceed 10% in accordance with EN 61000-3-2 through the entire dimming range.

The radio frequency interference must be in accordance with EN 55015 through the entire dimming range.

The unit shall be similar to electronic control gear as manufactured by Philips, Siemens or approved equal.

#### **Ballasts - Mercury Vapor**



Ballasts shall be suitable for use in the area to be installed.

Ballasts for 400 W lamp shall consist of two parts = gear housing and cover.

The housing and the cover are made of polyamide, which is heat, impact and stress resistant, with very good insulating properties.

The ballast box shall be protected to IP 54.

All ballast boxes shall include the integral ballast, the ignitor, the capacitors for power factor correction to min 0.85, a terminal block, and two properly rated fuses.

### **Ballast and Ignition Device - Sodium**

All Sodium lamps shall be equipped with individual control gears comprising a ballast and an ignition device.

The ignitor housing shall be able to withstand a +850C temperature. All control gears shall be equipped with capacitors so as to raise the power factor to 0.85. Ballasts shall have low losses which shall not exceed the following values:

- For 150 watts lamps, 20 watts losses.
- For 250 watts lamps, 30 watts losses.
- For 400 watts lamps, 36 watts losses.
- For 1000 watts lamps, 60 watts losses.

Ballasts shall operate with a voltage range of 210 to 230 V, with 50 Hz frequency.

### **Capacitors**

Power factor correction capacitors shall be metal foil dry type impregnated paper, metallized film or polypropylene film, encased in an insulated aluminium canister. Capacitors shall be rated at 250V, 50/60 Hz and BS EN 61049:1993. They shall be rated 800 volt, 50/60Hz.

Radio interference suppression capacitors shall be dry type ceramic or equivalent complying with BS EN 61048:1993 7. They shall be rated at 800 volts, 50/60 Hz.

### **Street Lighting Poles**

- A. Material and Finish: Hot dip galvanized folded steel.
- B. Section Shape and Dimensions: multi sectional, dimensions as per drawings.
- C. Height: As indicated on Drawings.
- D. Base: concrete base as per drawings.
- E. Accessories:
  - 1. Hand hole.
  - 2. Anchor bolts.
- F. Loading Capacity Ratings:

1. Luminaries Weight.
2. Luminaries and Bracket Effective Projected Area
3. Steady Wind.

**G. Lighting Unit**

1. IP54 or 65 as per drawings
2. Class II street lighting unit
3. Re lamping from front

**Part 3 INSTALLATION**

1. The contractor shall employ workmen who have had experience in installation of high masts.
2. High masts shall be installed on concrete bases as detailed on the Drawings. Erection of high masts and assembly of the luminaire head frame and raising and lowering gear shall be carried out in accordance with the manufacture's instructions. The contractor shall ensure that the foundations are suitable for use with the high mast installation proposed.
3. Location of masts shall be as shown on the approved working drawings and masts shall be plumbed vertical before final bolting down.
4. Masts shall be assembled as close as possible to the installation location, preferably on level ground, and using the manufacture's recommended tools.
5. Final setting and adjustment of the luminaires shall be carried out after all masts are operational.
6. Anchor bolts shall be supplied complete with accessories and coordinated with the civil Works described in section 6.19-"Civil Works for Electrical Installation".
7. High mast metal work shall be bonded to a separate earth rod as indicated on the drawings and also to the separate earthing cable connected to the distribution board earth bar.
8. Masts shall be of specified height and carry luminaires as indicated on the Drawings. Each luminaire shall house the required lamp oriented to give the correct illumination along the highway surface.
9. The high mast system incorporating mobile luminaire rings shall be capable of utilizing a purpose-made portable cage for maintenance purposes. The cage shall be obtained from the high mast supplier and be capable of carrying 2 persons plus servicing equipment. A safety device shall be provided for use within the cage.
10. A portable power tool shall be provided for raising and lowering of the luminaire ring from a remote position. Manual raising and lowering equipment where appropriate shall also be provided.
11. An extension lead of multi-core cable, fitted with multi-pin plug and socket shall be provided to enable testing of luminaires in the lowered position.

## **CIVIL WORKS FOR ELECTRICAL INSTALLATION**

### **SCOPE**

1. These Works shall consist of furnishing materials and constructing the following civil Works associated with the electrical installations:

- 1.1 Lighting column and high mast bases
  - 1.2 Traffic signal and traffic sign bases recesses and duct work
  - 1.3 Bridge parapet and amenity lighting recesses and duct work
  - 1.4 Vehicle and pedestrian underpass installations
  - 1.5 Feeder pillar bases and duct system
  - 1.6 Building and foundations for MV intake switching stations
  - 1.7 Package substation foundations
  - 1.8 Package MV switching station foundations and ducts
  - 1.9 Constructional Works for irrigation electrical installation and pump station
  - 1.10 Ducts
  - 1.11 Cable draw pits
- MATERIALS**

1. PVC (un-plasticized) duct shall be of specified diameter and nominal bore, as shown on the Drawings and of wall thickness depending on the diameter of the duct required, and suitable for burial in the ground. The installation shall be in accordance with Section 5.13 – “Pipe Culverts, Storm Drains and Utility Ducts”. Where duct installation requires to be bored as detailed on the Drawings, the Work shall be carried out in accordance with Section 2.09 – “Excavation and Backfill for Structures”.
2. Concrete shall be as specified and shall conform with the relevant requirements of part 5 – “Concrete, Steel and Structures”.
3. Reinforcing steel shall be mild steel conforming with the relevant requirements of part 5 – “Concrete, Steel and Structures”.
4. Draw pits shall be constructed of the materials as detailed in Section 5.14 – “Drainage and Utility Structures”. Draw pit covers shall be heavy duty cast iron and of the concrete infill type as specified.
5. Sand and sieved backfill material free from stones or other debris shall be provided for reinstating trenches after laying of cables and ducts. Interlocking duct or cable cover tiles shall give 50 mm minimum overlap on each side of the cables or ducts. An indicating tape or mesh shall be buried 200 mm below the finished ground surface above each run.

### **Inspection**

1. The duct system, draw pits and high mast, lighting column, sub-station and switching station bases, shall be checked by the Contractor. All ducts and draw pits shall be cleaned out where necessary and pulled through and any damage to bases shall be rectified. The threads on holding down bolts shall be in proper condition and shall be cleaned and eased before installation commences. Damaged or missing nuts, washers and spacers shall be replaced.

### **-EXIT SIGNS**

- Product Description: Exit sign fixture suitable for use as emergency lighting unit.

- Housing: Extruded aluminum or Sheet steel.
- Face: Clear polycarbonate with green pictogram according to standards.
- Directional Arrows: As indicated on Drawings.
- Mounting: As indicated on Drawings
- Battery: nickel-cadmium or Nickel Metal Hydride type, with 3 hours capacity and rated for 10 year life.
- Battery Charger: Dual-rate type, with sufficient capacity to recharge discharged battery to full charge within twelve hours.
- Lamps: 8W T5 Fluorescent or LED Strip.
- Input Voltage: 230 volts.
- Include TEST switch and AC ON indicator light, installed to be operable and visible from outside of assembled luminary.

**-EMERGENCY POWER SUPPLY (BATTERY KIT)**

- G. Product Description: Emergency battery power supply suitable for installation in ballast compartment of fluorescent luminaries, or in a special fire retardant metal box beside other lighting fixtures.
  - H. Lamp Ratings: Maximum 50W (Fluorescent, Compact Fluorescent, Halogen or LED).
  - I. Battery: Sealed nickel cadmium type with 3 hours capacity and rated for 10 year life.
  - J. Include TEST switch and AC ON indicator light, installed to be operable and visible from outside of assembled luminary.
- 2.

**PART 3 - EXECUTION**

**INSTALLATION**

1. Furnish, assemble, install and wire up complete, all lighting fixtures. Fixtures shall be complete with lamps, lamp holders and all necessary accessories. All fixtures shall be wired in accordance with temperature limitations.
2. Fixtures shall be rigidly mounted by approved means. Pendant-hung fixtures shall be equipped with approved ball type aligners.
3. Provide adequate protection for fixtures during construction. At completion of work all fixtures shall be clean and free from foreign material.
4. Support fluorescent luminaries directly from building structure by rod hangers and inserts or metal angle headers supported from framing structure of ceiling suspension system.

5. Support luminaries more than 600mm wide by a minimum of four hangers per luminaries, independent of ceiling structure or tee bars.
6. Install recessed luminaries to permit removal from below, to gain access to outlet or rewired fixture box.
7. Connect recessed luminary to boxes with flexible conduit and fixture wire.
8. Support recessed luminaries mounted in suspended ceilings with exposed tee bar grid system from the ceiling tee bar grid structure and secure thereto.
9. Cables shall loop in and out of bases of columns and bollards without joints. Cables shall terminate in a crimped cable socket.
10. Provide foundations for all requiring such poles shall be set plumb.
11. Verify that the lighting fixtures are compatible with the specified ceiling systems as indicated on the architectural drawings. Advise the Owner's representative of any discrepancies before placing the lighting fixture order.

#### TESTS

1. Test all circuits in accordance with the codes.
2. Test proper operation of lighting fixtures and controls.
3. Lighting levels in rooms shall be tested using a cosine and color corrected light meter to the requirements of CIBSE.
4. Submit test results.

END OF SECTION

## **SECTION 14620**

### **GENERATOR SET SYSTEM AND AUTOMATIC TRANSFER SWITCH**

#### **1.1 GENERAL**

##### **1.1.1 Work Included**

Provide all labor, materials, and equipment to furnish, install, and place in operation the power generation system in accordance with the contract documents and manufacturer's drawings and installation instructions. These specifications also describe requirements for the design, fabrication, and testing of the power system.

##### **1.1.2 System Description**

The electric power generating system shall have a site capability **AS INDICATED IN BOQ**, **0.80** power factor, **400** volts, Wye connected, three phase, **50** hertz. This power shall be applied for Standby operation.

##### **1.1.3 System Function**

The generator set shall include the capability of automatically controlling generator set operation. After starting, the unit will attain rated speed and voltage, and accept rated load. Generator set speed shall be controlled by the engine governor, while generator output voltage regulation shall be a function of the generator automatic voltage regulator. Manual adjustment of generator speed and voltage shall be provided.

##### **1.1.3.1 Single Generator Set operation**

The generator set start-stop sequence shall be initiated manually or automatically by closing or opening of a contact. The control system shall automatically engage the cranking motor, sense engine starting speed, disengage the motor, and arm the engine protection circuit.

The set shall immediately shut down in the event of overspeed, low oil pressure, high water temperature and overcrank. Cause of shutdown shall be indicated by a light annunciator. System logic shall prevent restart until fault is cleared. There shall be a provision for manual shutdown.

##### **1.1.4 Site Conditions**

The operating environment of the power generating system shall be:

Altitude:           **900** meter  
Max Ambient Temperature:**45**°C  
Fuel Type:         Diesel

##### **1.1.5 Submittals**

Submittals for approval shall include but not be limited to:

- Component List - A breakdown of all components and options.
- Technical Data - Manufacturer produced generator set specification or data sheet identifying make and model of engine and generator, and including relevant component design and performance data.

- Auxiliary Equipment - Specification or data sheets, including, transfer switch, battery charger ,jacket water heater, main circuit breaker etc .
- Drawings - General dimensions drawings showing overall generator set measurements, mounting location, and interconnect points for load leads, fuel, exhaust, cooling and drain lines.
- Warranty Statements - Warranty verification published by the manufacturer.
- Service - Location and description of supplier's parts and service facility including parts inventory and number of qualified generator set service personnel.

### **1.1.6 Service and Warranty**

The manufacturer shall have a local authorized dealer who can provide factory-trained servicemen, the required stock of replacement parts, technical assistance, and warranty administration. ( 2 YEARS FACTORY WARRANTY SHALL BE PROVIDED)

#### **1.1.6.1 Proximity to Job Site**

The manufacturer's authorized dealer shall have a parts and service facility within 30 km of the job site.

## **1.2 PRODUCTS**

### **1.2.1 Engine**

#### **1.2.1.1 Engine Equipment**

The engine shall be equipped with air filters, fuel filters and pressure gauge, lubricating oil cooler, filters, and pressure gauge, water pump and temperature gauge, service hour meter, flywheel, and flywheel housing when applicable.

#### **1.2.1.2 Cooling System , Engine Mounted Radiator**

Heat rejected to the engine jacket water shall be discharged to the atmosphere through a close-coupled radiator. The generator set shall be installed inside a large engine room and have a 30 % antifreeze/coolant mixture. The radiator shall cool the jacket water while the engine is operating at full site capability. Additional restriction affecting airflow shall not limit the radiator's capability to adequately cool at maximum site temperature. Suitable sized air inlet and outlet louvers shall be installed ( size of louvers shall be according to recommendation of generator set manufacturer).The radiator shall be fixed(normal) type.

#### **1.2.1.3 Exhaust System**

The engine exhaust system shall be installed to discharge combustion gases quickly and silently with minimum restriction. All pipework associated with the exhaust system shall be mild steel with a wall thickness not less than 5.4 mm internally and externally.Rust proofed joints between pipework and the silencer and the flexible coupling shall be flanged

The exhaust silencer shall be a high attenuation residential type ,sized and supplied by the engine supplier. It shall provide 20-30 dBA attenuation while imposing no more than 6.7 kPa (27 in H2O) restriction.

The silencer shall be mounted near the engine to minimize noise and condensation, and pitched away from the engine. A provision for draining moisture shall be included.

Double silencers for the set might be installed to get the required sound level.

A flexible connection shall be provided to connect the engine to the exhaust system. silencer and pipe work shall be supported from the roof slab . Anti vibration mounting devices shall be provided between the brackets and the structure.

The exhaust pipework shall leave the generator room through an aperture in the wall or the roof and shall rise vertically before terminating at an automatically operated gravity weatherproof CAP. A weather cravat shall be provided to the pipe work to prevent rain entering the building.

A drain cock shall be provided immediately after the silencer on an extended tube to clear the insulation.

Within the building the silencer and fixed pipework shall be insulated with 75mm thick mineral wool insulation. The insulation shall be secured by circumferential ties spaced at not more than 450mm apart. The insulation shall then be protected by fabricated hammered aluminum casings with a thickness of not less than 1.0mm. The casings shall be detachable at all bolted connections.

#### **1.2.1.4 Wiring and Conduit**

Engine and generator control wiring shall be multi-strand annealed copper conductors encased by cross-linked polyethylene insulation resistant to heat, abrasion, oil, water, antifreeze, and diesel fuel. Wiring shall be suitable for continuous use at 120C (250F) with insulation not brittle at -50C (-60F). Each cable will be heat stamped throughout the entire length to identify the cable's origin and termination. Cables shall be enclosed in nylon flexible conduit which is slotted to allow easy access and moisture to escape. Reusable bulkhead fittings will attach the conduit to generator set mounted junction boxes.

#### **1.2.2 Alternator**

The alternator(s) shall be rated for **stand-by** service at rating as in drawings and BOQ, **0.8 PF, 400 V**, three phase, 4 wire, **50 Hz, 1500 rpm**.

##### **1.2.2.1 Structure**

The generator shall be synchronous ,salient pole ,single bearing /double bearing , close coupled, drip proof and guarded, self excited / permanent magnet rotating field and brushless type, alternator is constructed to and comply with BS 5000 & BS 4999 with class H insulation with temperature rise to class B insulation above ambient .

##### **1.2.2.2 Voltage Regulator**

The automatic voltage regulator shall maintain generator output voltage by controlling the current applied to the exciter field of the generator.

The regulator shall be a totally solid state design which includes electronic voltage buildup and overcurrent protection. It shall incorporate 1:1 volts per Hertz characteristics with the regulated voltage a linear function proportional to frequency over a 30 to 70 Hz range.

The regulator shall be suitable for mounting within or external to the generator assembly, and have provision for remote voltage level control. As installed, the voltage regulator shall meet the applicable sections of the IEC (International Electrotechnical Commission).

#### **1.2.3 Speed control**

##### **1.2.3.1 Electronic Governor. ( for single & multiple unit operation )**



Woodward type or equal .Governor is to provide isochronous governing for single unit operation and, paralleling and load sharing for multiple operation of generator sets. It has zero percent (isochronous) setting and adjustable droop from zero percent to 10% droop. System is to include power supply unit ,magnetic speed pick-up, control module and actuator using fast response d.c motor or equally approved alternative .Governor is to be designed for fast –response and high precision of speed . (Frequency) control, automatic paralleling and load sharing and is to include speed adjustment to +/- 5% of normal while running and with remote control interface.frequency deviation under 25% sudden load change is not to exceed 0.5 hz recovering to stable speed condition of +/- 0.1 Hz in 0.5 seconds.

## **1.2.4 Fuel system**

### **1.2.4.1 Fuel daily tank**

An auxiliary fuel tank with enough capacity for 8 hours continuous running of generator set shall be provided. The tank shall comply with local codes and ordinances and incorporates threaded pipe connections, float switch level, sight level fuel gauge, and a high fuel level alarm contact wired to an indicating light on the generator set control cubicle. A manual shutoff valve on the engine supply line and a drain valve shall be included. Both integral base mounted and floor mounted tanks are acceptable

### **1.2.4.3 Fuel lines**

Heavy gauge, black seamless steel to BS 1387 or equal, treated internally with corrosion resistant, anti-acid resistant paint suitable for fuel and with joints sealed with PTEE tape. Change in direction and branching and jointing are to be with regular pipe fittings. Field fabricated and bent fittings are not to be used. Size of fuel lines is to be to generator manufacturer recommendations

## **1.2.5 Controls, Protection, and Monitoring**

The controls, protection, and monitoring systems of the generator set and its operation shall be the responsibility of the generator set manufacturer. All subsystem components, interfaces, and logic shall be compatible with engine mounted devices.

### **1.2.5.1 Controls - Generator Set Mounted**

The control panel shall be designed and built by the engine-generator manufacturer. It shall be mounted on the generator set and incorporate 100% solid state microprocessor based control circuitry, sealed dust tight, watertight modular components with metal housings, and digital instrumentation. The panel shall be labeled with ISO symbols and comply with IEC 144, IP 22.

The panel shall include but not limited to the following equipment

- Metering equipment:-
  - AC voltage 3 phase .
  - AC amps.
  - KW

- KVA
  - KVAR
  - PF
  - Frequency
  - DC Voltage
  - Coolant temperature.
  - Oil pressure
  - RPM
  - Hours run
- Controls
- Auto start / stop.
  - Emergency stop
  - Phase selector switch
  - Voltage control
- Shut down annunciation.
- Low oil pressure
  - High coolant temperature
  - Over speed
  - Overcrank
- Indicating lights
- Emergency stop
  - Fault shutdown
  - Fault alarms:

## **- PROTECTIVE RELAYING**

- Over/under voltage
- Reverse power relay
- Over/under frequency
- Over current

### **1.2.5.2 Circuit Breaker - Generator Set Mounted**

The main line circuit breaker shall be mounted and connected in a guarded drip-proof enclosure meeting IP 22 and IEC 144.

### **1.2.5.3 Battery Charger**

A (constant voltage 5-10 ampere) battery charger shall be provided which shall accept 220 volt AC single phase input to provide 24 volt DC output. It shall be fused on the AC input and DC output, the charger shall be housed inside generator control panel.

### **1.2.5.4 Automatic Transfer Switch**

#### **Type**

Wall or floor mounted ,galvanized sheet steel cubicle of equal construction to control cubicle comprising two main contactors or circuit breakers and controls necessary for automatic transfer of power supply from normal source to standby source ,voltage sensing control relay and time delay relays to signal generator start

&stop, auxiliary switches and indicating lights etc as necessary for the required operation of the system.

### **Operation**

When voltage and/or frequency for any phase drops below an adjustable setting ( 60%-90%) of normal supply , power failure relay is to actuate engine starting control whilst normal mains contactor is to open . After an adjustable period of 0 – 10 seconds from sensing stabilized rated voltage and frequency of generator at the ATS, the emergency contactor is to close. Upon restoration of normal mains supply to above 95% of rated voltage and/or frequency for an adjustable preset period of 2-60 minutes , emergency contactor is to open and normal mains contactor is to close.

### **Construction**

- Two contactors(for ratings equal or below 800 KVA) or motorized molded case circuit breakers(for ratings above 800 KVA), 3 phase ,4 pole , 400v electrically and mechanically interlocked. Contactors/breakers should be capable of interrupting at least 10 times rated current inductive or non inductive loads under normal service conditions and are to have replaceable main arcing contacts and arc quenching devices.
- Controls which includes but not limited to
  - Mode selector switch
  - Mains voltage sensing relays {adjustable}
  - Delay on start timer{ adjustable} –prevents the generator set starting on momentary mains interruptions or during transient mains voltage excursions.
  - Generator voltage sensing relays.{ adjustable}
  - Delay on transfer timer { adjustable } - allows the generator set to stabilize before transfer of the load to it or from the failed or out of limits mains supply
  - Delay on retransfer timer { adjustable} -keeps the load on the generator set until the restored mains supply stabilizes.
  - Cool down timer { adjustable} – allows the engine to run at no load after retransfer of the load to the restored mains supply.
- Status indications
  - ◆ Mains on load
  - ◆ Mains available
  - ◆ Generator available
  - ◆ Generator on load

## **1.3 EXECUTION**

### **1.3.1 EXAMINATION**

**Verification of Conditions:** Examine the areas to receive the Work and the conditions under which the work would be performed. Remedy conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

### 1.3.2 INSTALLATION

**General:** Install power generation system in accordance with the final submittals and the manufacturer's instructions. Verify measurements and dimensions at the project site and coordinate with the Work of other trades. Install at locations shown, in correct alignment and elevation, plumb, level, straight and true. Use procedures that will prevent damaging or soiling the Work during installation.

### 1.3.3 FIELD QUALITY CONTROL

**Tests:** Conduct an operational test after installation to indicate that operation is satisfactorily under actual installed conditions. An installation check, startup, and building load test shall be performed by the manufacturer's local representative. The employer and the employer's regular operators and maintenance staff shall be notified of the time and date of the site test. The tests shall include the following:

- Fuel, lubricating oil, and antifreeze shall be checked for conformity to the manufacturer's recommendations, under the environmental conditions present and expected.
- Accessories that are normally function continuously (either if the generator set is on or off) shall be checked prior to cranking the engine. These shall include: heaters, battery charger, remote annunciator, etc.
- Startup under test mode to check for exhaust leaks, path of exhaust gases outside the building, cooling air flow, movement during starting and stopping, vibration during running, normal and emergency line-to-line voltage and frequency, and phase rotation.
- Automatic startup to test remote-automatic starting, transfer of the load, and automatic shutdown. Prior to this test, all transfer switch timers shall be adjusted for proper system coordination. Engine coolant temperature, oil pressure, and battery charge level along with generator voltage, amperes, and frequency shall be monitored throughout the test. An external load bank shall be connected to the system if sufficient building load is unavailable to load the generator to the nameplate kW rating.

**Start Up:** Provide factory trained service technician to oversee and make adjustments during start up.

**Manufacturer's Field Service:** At the start of the installation, periodically as work progresses, and after completion, furnish the services of the manufacturer's technical representative at the job site as necessary to assist in laying out the work, and furnish technical assistance to the installer as may be required.

### 1.3.4 ADJUSTING

Upon completion of the work repair surfaces that have been permanently stained, marred, or otherwise damaged. Replace work which is damaged or cannot be adequately cleaned as directed..

Adjust installation to provide the specified operation. Repair or replace components which do not operate as specified.

### 1.3.5 CLEANING

Upon completion of the work, remove unused materials, debris, containers and equipment from the project site. In addition to the initial cleaning procedure required, and not more than 2 days before occupancy by the Employer, clean the work as recommended by the manufacturer.

### **1.3.6 PROTECTION**

**General:** Protect the work from damage during the construction period so that it will be without indication of wear or damage at the time of acceptance by the Employer.

### **1.3.7 ORIENTATION**

The system manufacturer's authorized dealer shall provide a complete orientation for the owner's engineering and maintenance personnel. Orientation shall include both classroom and hands-on instruction. Topics covered shall include control operation, schematics, wiring diagrams, meters, indicators, warning lights, shutdown system and routine maintenance. Describe loads connected to the system and restrictions for future load additions.

**END OF SECTION**

## **SECTION 14710 FIRE ALARM SYSTEM**

### **General**

The contractor shall supply and install the fire alarm system as herein specified and as shown on the drawings. The system shall be of the **Microprocessor-based Intelligent Analogue Addressable type** with continuous monitoring of analogue quantities and automatic adjustment of alarm threshold.

The system and installation of the system shall be in accordance with NFPA standard and in accordance with the latest requirements laid by Local Civil Defense authorities.

All equipment used in the system shall, as far as practicable, be designed and provided by single manufacturer, and shall be compatible with relevant sections of the overall security systems.

The Fire alarm control panel shall have minimum ingress protection of NEMA 1 or IP 30 and **shall be suitable for recessed mounting at locations indicated on the drawings.**

### **Terminology and Definitions**

Unless otherwise specified, the definitions and terms used in this specification shall be in accordance with **NFPA72, NFPA 101, and other UL related parts and the** documents referred in these standards.

In addition, The following definitions shall apply:

#### 1. Analogue /Addressable System

Each detector in addition to being addressable outputs a digitally encoded “Analogue” signal which varies in the short-term’ due to fault and alarm conditions and in the long-term due to environmental soiling.

### **Environment**

Unless otherwise specified, all equipment used in the system shall be suitable for continuous operation in the following ambient conditions:

Temperature	: 0 to +40 °C
Relative humidity	: 0% to 93 % RH non-condensing

### **System Features**

- The system shall consist of equipment provided for receiving end indicating all signals initiated from the associated services or manual call points and activating alarm sounders and signaling devices.
- System response to any alarm condition must occur within [7] seconds, regardless of the size and the complexity of the installed system.
- The system shall be capable of future expansion without obsoleting any of the original equipment.

- Facility for testing the sensors and manual call points of any loop, without affecting the function of other loops of the system shall be available.
- Dedicated telephone lines for transmission of emergency calls shall not be used for any other purpose.

### **Microprocessor System**

- The system shall be of the True Distributed Intelligence, including microprocessor-based Detectors and Modules.
- The communication network between the panels shall operate with the specified wiring system. Communications faults shall be announced at all panels. Transmission errors shall be indicated at all panels in the network
- All input signals received by the central control system from the outstations shall be automatically processed and presented to the operator by means of main fire alarm display
- The system shall be continuously self-monitoring type. Any faults and malfunctions in the system shall be displayed.
- Ability to download all system applications programs and “firmware” from a computer through a single point in the system.
- The capacity of data processing system shall include 25 percent spare capacity for future use.

### **Communication Network**

- The system shall be of Multi-Priority, token passing, peer-to-peer network wired as Class A (Style 7).
- The communication network between the panels shall operate with the specified wiring system. Communications faults shall be announced at all panels. Transmission errors shall be indicated at all panels in the network
- A loop type network shall be provided by connecting each panel in series starting from and ending at the same panel. It shall be possible to expand the network in the future without affecting the existing system.
- Any defective device in the detection loop shall be automatically bypassed without affecting the normal function of the rest of the system.
- The network shall be capable of connecting [50] panels per secured network.

### **Looping**

- The fire alarm and detection system shall be divided into Loops to comply with NFPA.
- A fault in any one loop shall not interrupt the operation of other loops.
- The system looping shall be definable within the system program to allow the quick identification of the alarm loop and testing of the installed system based on the physical layout of the system, and not on the wiring of the field circuits connected to the Fire Alarm Control Panel.

- Loop capacity shall be minimum 125 addressable devices per loop.
- The maximum loop distance shall not be less than 1km.

### **General Indication and Display**

- General display shall incorporate an assigned area for each detector indication with LED indicator for each area arranged in accordance with manufacturers standard design
- A display diagram shall be provided. The diagram shall include a representation of the building(s) with a clear display of all areas covered by the fire alarm system including the details of building entrances; circulation areas escape routes, and the division of loops.

### **Initiating Detectors**

- The automatic fire alarm detectors and modules shall be analog addressable devices.
- The automatic fire detectors shall be fixed to the installation by mean or plug-in bases.

### **Alarm Signals**

- The system shall provide fully monitored output lines to activate audible alarm signal.
- The response time for giving general alarm shall be in accordance with NFPA or BSEN54.
- Alarm signals shall not be routed through private exchange or any other equipment vulnerable to fire  
Transmission of alarm signals shall be fully automatic, once initiated.
- The sound levels of fault warning sounder shall be at least 5 dBA above the average ambient sound level in that area. Sound level of fault warning sounders at operator location shall be minimum 70 dB(A).
- The sound levels of alarm sounder shall be at least 75 dBA at 3 meter but not more than 120 dBA. To ensure that public mode signal are clearly heard, they shall have a sound level of at least 15 dBA above the average ambient sound level in that area
- The Indicating circuit used in high noise area's, as mechanical rooms shall be combined horn and strobe units.
- Sounders shall be installed/wired in detector loops or on separate sounder circuits, as per the approved manufacturers standard.

### **Fire Telephone System**

- The telephone circuits shall be annunciated and cause an audible alarm whenever a call is placed to the control center from a remote telephone location.
- A Red master telephone handset with flexible-coiled 5-foot cord shall be provided and recessed within a protective enclosure at the Main Control Panel.
- The system shall be capable of handling single or simultaneous conversations with as many as five phones connected. The phone system circuits shall be designed for clear, intelligible two-way conversation between all phones of the system.



## **Electromagnetic Interference**

The fire alarm end detection system shall be equipped to comply with NEC 760 or BS 800 and BS 6667, in respect to the limits of electromagnetic interference.

## **System Components**

### **Fire Alarm Control Panel**

The Control Panel (CP) shall be the central processing unit of the system, receiving and analyzing signals from fire detection Initiating devices. Providing audible and visual information to the user, initiating automatic alarm response sequences and providing the means by which the user interacts with the system.

All CP's shall have the following minimum standard requirements:

- UL listed or LPCB approved
- Multi-Priority, token passing, peer-to-peer network connection of up to 64 system nodes wired as <Class A (Style 7)> <Class B (Style 4)>.
- “Power supply and charger
- “Battery supervision.
- “Tree Distributed Intelligence, including microprocessor-based Detectors and Modules.
- “Removable, Interlocked terminal blocks for the connection of the field wiring to the Fire Alarm Control Panel.
- Advanced Power Management
- Dead Front Construction.
- “Standardized software
- “Operator Features which may include but not limited to the followings:
  - Control keys
  - Function keys
  - Acknowledge keys
  - Display action keys
  - Entry key
  - Character alphanumeric liquid crystal display
  - Alarm supervisory and trouble LED indication
  - Power on indicator
  - Common Alarm indicator
  - Common Fault indicator
  - CPU Fail
  - Disable, Isolate

The control keys shall be programmable; they may used for manual activation of A/C shut down etc.

The ‘Function Keys’ Display Action Keypad and the Entry Keypad shall be user friendly. Operations shall include Enabling and Disabling circuits, turn control points on or off, set time and date. Display historical logs etc.

The acknowledge key pad shall have the following functions:

- Alarm Acknowledge
- Supervisory Acknowledge
- Trouble Acknowledge

- Alarm Silence
- System Reset

## **Optical Smoke Sensor**

The optical smoke Sensors shall be of the analogue addressable type and shall be capable of detecting visible combustion gases from fires. Optical smoke Sensors shall comply with UL or BS 5445:part 7

The optical smoke Sensors shall employ the forward light-scatter principle using optical components.

The design of optical smoke Sensors sensing chamber shall be optimized to minimize the effect of dust deposits over a period of time. The sensors shall incorporate screens to prevent all but the-very small insects entering the sensing chamber. The optical smoke Sensors shall have high resistance to contamination and corrosion.

The electronic assembly of optical Sensors shall be encapsulated in high resistively epoxy resin.

The optical smoke Sensors shall incorporate an LED clearly visible from the outside, to provide indication of alarm actuation.

## **Heat Sensors**

The heat Sensors shall be of the analogue addressable type. They shall be capable of detecting rapid rise in temperature and fixed absolute temperature.

The heat Sensors shall meet the requirements of either UL or BS 5444:part 5 and BS 5445:part 8. The heat Sensors shall employ two heat-sensing elements with different thermal characteristics to provide rate of rise dependent response.

The temperature sensing elements and circuitry of heat sensors shall be coated with epoxy resin to provide environmental protection.

The heat Sensors shall incorporate LED, clearly visible from outside to provide indication of alarm actuation.

## **Addressable Manual Call Points**

Addressable manual call points shall monitor and signal to the control and indicating equipment, the status of a switch operation by a "Break Glass" assembly. The addressable manual call point shall comply with BSEN54 or UL.

The addressable call points shall be capable of operating by means of thumb pressure and not require a hammer.

The addressable call points shall be capable of being mounted in a weatherproof casing with ingress protection to IP 66,

The addressable call points shall incorporate a mechanism to interrupt the normal addressable Loop scan to provide all alarm response within less than 1 second and shall be capable of being tested using a special key, without the need of shattering the glass.

The addressable call points shall be field programmable to trigger either an alert or an evacuate response from the central indicating equipment. The addressable call points shall provide an integral LED to indicate activation.

All inscriptions on the manual call points shall be permanently made on the cover and not on the glass.

The alarm condition shall be maintained until reset by an authorized person by means of a special tool provided for that purpose.

## **Duct Smoke Detectors**

Duct smoke detectors shall sample air from the a cross section of the air duct.

Detectors shall be suitable for duct velocities from 300 to 4000 feet per minute and shall be provided with duct housing assembly.

The unit shall be supplied with a duct probe tube of the required length to suit the duct. Duct smoke detectors shall be supplied and installed under another section.

## **Smoke Sensors in the Lift Lobby**

Activation of any smoke detector in the lift lobby (if any) other than the main or lift machine rooms, shall initiate a signal to the lift control panel to cause all cars in all groups that serve that lobby to return non-stop to the main landing.

If the smoke detector at the main landing is activated, the cars shall return to an approved alternate landing (unless the fireman's switch is in the "on" position).

## **Addressable Relay Output Module (Control Module)**

The addressable relay output module shall provide a volt free changeover relay contacts operated by command from control and indicating equipment. The contacts of the addressable relay output module shall be rated at 1 amp at 24 volt DC. The module shall monitor the relay coil for open circuit and transmit the fault signal to control and indicating equipment.

The addressable relay output module shall be capable of deriving power for its operation, from the addressable loop. It shall have a red LED indication when the contact has operate.

## **Addressable Contact Monitoring Module**

The addressable contact monitoring module shall provide monitoring of the status of switched input signals from either NO or NC contacts. The module shall provide a red LED indicator when a contact has operated.

The addressable contact monitor module shall be capable of deriving its power directly from the addressable loop.

## **Line Isolator Module**

The line isolator module shall provide protection on the addressable loop by automatically disconnecting the section of wiring between two modules, where a short circuit has occurred.

The line isolator nodule shall derive power directly from the addressable loop.

The line isolator module shall provide a LED indication that the module has tripped.

## **Door Holder and Release Devices**

Door hold and release devices shall be of the magnetic type and shall be suitable for wall or floor mounting application. The door hold shall keep the door in closed position by means of an electromagnet, which is continually energized and shall release the door when de-energized.

The door holds unit shall consist of a mutual plate which is fitted to the door and a solenoid unit fitted on the adjacent wall or floor as appropriate. Unless otherwise specified, the door holds device shall operate from 24V D.C supply.

The active pad of the door hold device shall be fixed to the immovable surface with -the “keeper being fixed to the movable surface.

## **Alarm Sounders**

All fire alarm sounders within the building shall have similar Sound characteristics except in areas of high background noise All alarm sounders shall operate within a frequency range of 600 Hz to 1000 Hz, unless this would be masked with background noise frequencies. Alarm sounders shall be wired either in detector loop circuits or on separate sounder circuits in accordance with the approved manufacturer’s standard design.

## **Fire Telephone Jacks**

- Remote firemen’s telephone jacks shall be flush mounted
- Jacks shall be with the inscription “FIRE FIGHTER TELEPHONE”.
- Provide one fire telephone handset enclosure at BMS room with 5 handset

## **Battery /Charger Console**

Battery /Charger console shall be provided where it is not an integral part of the control panel and in which case it shall be a completely self-contained console enclosing both nickel cadmium batteries and automatic battery charger for dc power.

The charger shall be two-rate constant potential unit maintaining the batteries fully charged under all service conditions. After an AC power failure longer than 10 seconds, a timer shall automatically switch the charger to its high rate mode. Following the predetermined high-rate charge period, the timer shall automatically return the batteries to float charge. A remote initiation of the timed high-rate charge mode shall be possible.

The front panel shall include a dc voltmeter, a DC ammeter, indicator lights for float and high-rate charge modes, a push-button permitting manual initiation of the timed high-rate charge mode.

The front of the cabinet shall be provided with hinged doors held closed by magnetic catches. Built-in stepped steel shelves shall position the rows or translucent plastic cells for visual check of electrolyte levels.

Access to the charger compartment shall be by a lift-off top cover, held in place with screws.

The unit shall be ventilated through louvers

The cabinet shall be made of sheet steel finished in baked gray enamel.

The unit shall be provided with float potentiometer, high-rate potentiometer, ac & dc fuses failure alarm relay, 24 hour automatic timer, earth detectors, ac pilot light, etc.

### **Repeater Panel**

The repeater panel shall be sited as shown on drawings. The repeater panel front fascia shall match the main fire alarm panel and also has the same operational function capability.

The communication with fire alarm panel shall be by means of microprocessor based data communication system.

### **Graphic Terminal**

- A PC based GCC (Graphic Command Central shall be installed In the BMS Room. It shall be possible from the GCC to monitor and control all of the points within the entire Network.
- The unit shall have the following features:
  1. Monitor and control all points connected to the system
  2. Store the complete Network System Historical Logs.
  3. High-resolution color Graphics.
- The PC shall be the latest at time of purchasing with DVD drive
- A parallel printer shall be provided in the same Room to keep a hard copy of all system events with stamped date and time.
- The operating system for the workstation shall be windows XP with multi-tasking facility

### **Main Fire Alarm Control Center (FACC)**

The main fire alarm control center FACC shall monitor the operation of the FAPs as follows:

- Receive status information of alarm, supervisory and fault conditions from FAPs
- Receive command signals from the main graphic display terminal and the control terminal (CT)
- Transmit data to the event printer (EP)
- Transmit data to the building automation system (BAS) and public address system

The constituents of the FACC main fire alarm control center (FACC) are as follows but are not limited to:

- Central processing unit (CPU)
- Display and control unit
- Audio module (AM)
- Communication interfaces with the system and building automation
- Emergency power supply (PS)
- Master operating system including master system, communication and diagnostics

## **General Requirements**

The fire alarm and detection system shall be integrated with associated and ancillary systems described in these specifications.

Indications and detectors associated and ancillary equipment shall be taken into account in calculating the maximum load of the fire alarm and detection system power supply.

Faults in equipment for other functions shall not affect the performance of the fire alarm and detection system.

Circuits of all signals to and from ancillary systems via potential free contacts located in fire alarm control panel shall be monitored by fire alarm control panels.

Fire alarm system must always take priority over all the ancillary systems and shall not be delayed in operation by any automatic or manual event.

The layout of control panels of the integrated security system in the central control room shall be arranged so that the fire alarm controls cannot be confused with other controls.

All faults shall be registered by audible and visible fault alarms. The visible fault alarm shall be in yellow LED's.

All parts of other ancillary systems not directly connected to fire alarm system, but essential for its continued operation shall be monitored.

## **Conduits**

Conduits shall be used where fire rated cables are not used or when an alternative cable is considered by the contractor. Conduits shall be rigid steel type where used exposed and nonmetallic rigid PVC type where used embedded or above false ceiling, to the approval of Engineer and of local civil Defense Authorities.

## **Cables**

Cables shall be as specified under 'WIRES & CASLES'. All wires and cables of the system shall be sized to avoid any unacceptable voltage drop.

## **Inspection and Verification**

1. Upon completion, arrange for the manufacturer to make a complete inspection and adjustment of the system including all components, to ensure that:
  - The system complies with the contract documents, the manufacturer's recommendations, and the applicable codes and standards
  - The system functions in accordance with the drawings and specification in both the supervisory and alarm modes, including testing or operation of all alarm initiating devices to verify their operation.
2. During the inspection, provide staff as requested by the manufacturer as well as any required equipment such as ladders and scaffolding. Obtain information on staff requirements from the manufacturer before submitting a tender.

3. Submit the following to the Engineer:
  - Certificate of verification confirming that inspection has been completed and listing the conditions on which the inspection and verification are based
  - Test report on all equipment checked during verification, including panels, annunciators, bells, manual stations and automatic detectors

## **Testing and Commissioning**

### **1. Preliminary Tests**

Upon the completion of the installation, the system shall be subject to functional and operation performance tests including test of each installed initiating and notification appliance. Tests shall include the meggering of all system conductors to determine that the system is free from grounded, shorted or open circuits. The megger test shall be conducted prior to the installation of fire alarm equipment. If deficiencies are found corrections shall be made and the system shall be re tested to assure that it is functions.

### **2. Acceptance Test**

Provide the service of competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and commissioning of the system. Testing shall be in full accordance with NFPA 72 section 7.2.2.

3. Testing shall include all auxiliary functions, such as elevator recall, fan shutoff, and damper operation. The use of open flame or live smoke will not be permitted.
4. Submit seven (7) copies of the approval certificate and verification report to the Engineer after completion. Insert one (1) copy in the operation and maintenance manuals
5. Demonstrate complete system to Civil Defence for their approval and certification.

**END OF SECTION 16721**

SECTION 14729  
SERVILLANCE CAMERAS & CCTV SYSTEM

**PART 1– GENERAL**

- ❖ CCTV Monitoring System shall be of latest design incorporating all power and signal wiring as per manufacturer's standard.
- ❖ The building surveillance shall be met through closed circuit television (CCTV) system. The surveillance system shall be color PAL system suitable for operation in Jordan and must be of latest design and product range.
- ❖ The contractor will include in his price all camera fixings (brackets) as may be required for proper fixing and proper functioning.
- ❖ The CCTV system shall be supplied and installed as ONE package inclusive of all conduiting, wiring, accessories, equipment and materials.
- ❖ At any stage of construction, the Engineer may ask the Contractor to provide more cameras at additional costs. The Contractor's system shall be capable of reasonable expansion.

**SCOPE OF WORK**

The contractor shall supply, install and commission as provisional item the CCTV system as ONE package, having the following as a minimum:

- Digital Video Recorders (DVRs)
- Microprocessor-Based, Full Cross-point Video Matrix Switching with Control System.
- High resolution Motorized Dome Camera System
- Indoor Fixed Dome Camera System
- Fixed Camera with Enclosure.
- (Low loss) Cable as per drawings
- Raceways (trunking/ conduit/ cable trays /duct etc
- All accessories & sundries

The specifications of the items may differ from one supplier to another. Thus the specifications should be treated as a guideline. However all the items shall technically match to provide the required functions.

**PART 2 – PRODUCTS**

**2.1 DIGITAL VIDEO RECORDER**

- ❖ The digital video recorder (DVR) shall provide a high-quality recorder capable of storage and playback of images from 1 to 16 camera inputs at a simultaneous refreshing recording rate of up to 30 images per second (PAL) at CIF resolution with a CD-RW as standard equipment. The DVR shall possess a watchdog system, triplex operation, Windows 2000 operating system with Service Pack 4 with the latest security updates from Microsoft, watermarking of each frame, inputs for external alarms, video motion detection, and scheduled event recording. Remote software shall be provided for operation via PC, web, and Pocket PC handheld devices.

**The DVR shall meet or exceed the following design and performance specifications:**

**PROCESSOR:**

1. Processing Unit: Pentium® 4, 2.8 GHz processor with 256 MB of RAM
2. Recording Modes: Continuous, motion detection, alarm activation, or scheduled recording



3. Storage: Hard drive with enough storage for 31 days at a minimum resolution of 4CIF or 480 TV lines
4. Operating Software: Windows 2000, Service Pack 4
5. Signal Format: PAL
6. Resolution: PAL 352 x 288, 704 x 288, 704 x 576, 720 x 480, or 720 x 576 pixels
7. Frame Rate: PAL
  - CIF: 400 ips
  - 2CIF: 96 ips
  - 4CIF: 64 ips
8. Functions: Operate as a recorder and a full-duplex multiplexer
9. PTZ Control: Pan, tilt, and zoom functions via RS-422 communications & coaxial.
10. Viewing/Recording: Configurations of full screen, 4, 9, 12, or 16 cameras, or custom designed display views
11. Full-Triplex Operation: Simultaneous playback and live viewing while recording live images
12. Programmable Schedules: 24 individual schedules
13. Program Modes: Motion event, alarm input, or continuous recording
14. Hardware Watchdog System: A hardware device to monitor the system clock for Windows lockup; upon lockup of the system the recorder shall automatically reboot without losing any of the programmed settings
15. Password Protection: Four user levels of protection for setup functions, operation, and system exiting
16. Motion Detection: Built-in motion detection for each camera to start recording or to increase the recording rate of the system
17. Motion Areas: Selectable detection area and sensitivity for each camera
18. Alarm/Motion Activation: Alarm input will start the unit recording, or if already recording, increase the recording rate and image quality
19. Pre-Alarm or Pre-Motion Recording: Record images for up to 60 seconds before the alarm sensor has been activated
20. Bandwidth Throttling: Network throttling of transmitted video
21. Alarm History Log: Available through a query
22. Alarm Outputs: Sixteen dry contact alarm outputs to activate external devices
23. Motion Activation: When a unit is in scheduled time recording and a camera detects motion or an alarm is activated, the system shall begin recording the event
24. Remote Control: Full remote control operation of pan, tilt, and zoom functions via TCP/IP protocol and RS-422 interface
25. LAN/WAN Connection: Software and hardware provided for viewing and controlling DVR over the network
26. Video Quality: High-quality video recording of at least VHS grade compared to the original video; supports PAL video
27. Color Palettes: Minimum of 16 million color palettes
28. Gray Scale: 256 shades
29. Backup: A backup management system is to be provided to back up data to external devices (CD or other storage devices) without interrupting hard disk recording
30. Hard Disk Drives: From 80 GB up to 1TB
31. Programming: On-screen programming and operation through a PC keyboard or mouse.
32. Digital Zoom: Digital zoom of the image on the screen during playback modes
33. Authentication: Software provided for image verification of each image recorded
34. Connectors:
  - 16 BNC video inputs plus 16 looping video outputs with automatic termination
  - Two 9-pin, D-type connectors for COM 1 and COM 2 ports (disabled)
  - Two 6-pin, mini-DIN connectors for a mouse and keyboard
  - One 15-pin, D-type port for a PC monitor connection
  - One 25-pin D-type port for Printer connection
  - One S-video jack for analog monitor output (disabled)

- Two multiplexed analog video outputs (optional)
- One RJ-45 connector for network connection
- Four RJ-45 ports for RS485/RS422 support
- Depending on model, eight or sixteen push-in connectors for alarm inputs and eight or sixteen push-in connectors for relay outputs
- Six high-speed USB 2.0 ports

35. Recommended PC Requirements

- Processor: Pentium III or 4, or AMD with 800 MHz minimum processor speed
- Memory: 128 MB of RAM
- Video Card: VGA with minimum of 64 MB of video RAM
- Resolution: 1024 x 768 display, 32-bit color
- Monitor: SVGA or XGA with minimum of 1024 x 768 resolution
- Operating System: Windows 2000 (SP4) and Windows XP, DirectX 8.1
- Internet Explorer: 5.5 or later
- Disk Space: 500 MB of free space

**2.2 INDOOR MOTORIZED DOME CAMERA SYSTEM (Wide Dynamic Range)**

- ❖ The indoor CCTV camera dome system shall consist of a dome drive with a variable speed/high speed pan and tilt drive unit with continuous 360° rotation, 1/4-inch high resolution color/black-white CCD camera, motorized zoom lens with optical and digital zoom and auto-focus; and an enclosure consisting of a back box, lower dome, and a quick-install mounting.

**DOME DRIVE**

**The variable speed pan and tilt drive shall meet or exceed the following specifications:**

1. Pan Movement: 360° continuous pan rotation
2. Vertical Tilt: Unobstructed tilt of +2° to -92°
3. Automatic Preset Speed: Pan speed of 360° and a tilt speed of 200° per second
4. Presets: Eighty preset positions with a 20-character label available for each position.
5. Preset Accuracy: +/- 0.1°
6. Prop. Pan/Tilt Speed: Speed decreases in proportion to the increasing depth of zoom
7. Motor: Continuous duty, variable speed, operating at 18 to 30 VAC, 24 VAC nominal
8. Limit Stops: Programmable for manual panning, auto/random scanning, and frame scanning
9. Alarm Inputs: Seven N.O./N.C. dry contacts
10. Alarm Outputs : One auxiliary relay output and one open collector auxiliary output
11. Alarm Action: Individually programmed for three priority levels, initiating a stored pattern or going to a pre-assigned preset position
12. Auto-sensing: Automatically sense and respond to protocol utilized for controlling unit whether Coaxial or RS-422
13. Auto Flip: Rotates dome 180° at bottom of tilt travel
14. Password Protection: Programmable settings with optional password protection
15. Video Output Level: Normal, or high to compensate for long video wire runs
16. RJ-45 Jack: Plug-in jack on dome drive for control and setup of unit.

**The high resolution CCD camera shall meet or exceed the following specifications:**

1. Image Sensor: 1/4-inch
2. Scanning System: 2:1 interlaced output
3. Effective Pixels: PAL – 724 X 582
4. Horizontal Resolution : PAL – >470 TVL
5. Lens: F1.6 (f=3.6-82.8 mm optical, 23X optical zoom, 10X electronic zoom)
6. Programmable Zoom Speeds: 2.9, 4.2, or 5.8 seconds
7. Horizontal Angle of View: 54° at 3.6mm wide zoom – 2.5° at 82.8mm telephoto zoom
8. Focus: Automatic with manual override
9. Sensitivity at 35 IRE:
  - 0.08 lux at 1/1.5 sec shutter speed (color)
  - 0.013 lux at 1/1.5 sec shutter speed (B-W)
  - 0.3 lux at 1/50 sec shutter speed (B-W)
10. Synchronization: Internal/AC line lock phase, V-sync
11. White Balance: Automatic with manual override
12. Shutter Speed: PAL – 1/1.5-1/30,000
13. Iris Control: Automatic with manual override
14. Gain Control: Automatic/off
15. Video Output: 1 volt peak to peak, 75 ohms
16. Video Signal-to-Noise: >50 dB
17. Type of Lighting: Menu selection of lighting for optimum camera performance.
18. Wide Dynamic Range: 80X
19. Motion Detection: Three sensitivity levels per zone

**BACK-BOX AND LOWER DOME:**

**The back box and lower dome shall be Pendant Standard type and shall meet or exceed the following specifications:**

1. Ratings: Meets NEMA Type 4X, IP66 standards
2. Alarm Inputs: Seven alarm inputs
3. Operating Temperatures: Maximum temperature range of -4.0° to 45°C for two hours, and a continuous operating range of -4.0° to 35°C continuous operation
4. Construction: Aluminum
5. Dome: Smoked
6. Certifications: UL and cUL, FCC Class B, and CE Class B

**2.3 INDOOR MOTORIZED DOME CAMERA SYSTEM**

- ❖ The Dome system shall be small, 4.1-inch diameter dome, indoor pendant type. A high resolution camera shall transmit video over coaxial cable. Pan/tilt operation shall be performed with controllers that transmit on RS-422 cables. On-screen programming shall allow easy setup of the dome's many features.
- ❖ Variable speed capabilities of the Dome shall range from a fast motion of 140 degrees per second to a smooth speed of 0.4 degrees per second. The system shall be capable of continuous

360 degrees rotation and shall have an auto flip feature that allows the dome to rotate 180 degrees and reposition itself for uninterrupted viewing of any subject that passes directly beneath the dome's location.

**DOME DRIVE**

**The variable speed pan and tilt drive shall meet or exceed the following specifications:**

1. Pan Movement: 360° continuous pan rotation
2. Vertical Tilt: Unobstructed tilt of +2° to -92°
3. Automatic Preset Speed: Pan speed of 140° and a tilt speed of 80° per second
4. Presets: 64 presets. Pan speed of 140° per second and tilt speed at 80° per second.
5. Preset Accuracy: +/- 0.5°
6. Proportional Pan/Tilt Speed: Continually decreases pan and tilt speeds in proportion to the depth of zoom
7. Motor: Continuous duty, variable speed, operating at 18 to 30 VAC, 24 VAC nominal
8. Limit Stops: Programmable auto, random and frame scanning
9. Auto-sensing: Automatically sense and respond to protocol utilized for controlling unit whether Coaxial or RS-422 protocol.
10. Auto Flip: Rotates dome 180° at bottom of tilt travel.
11. Password Protection: Programmable settings with optional password protection
12. Diagnostics: On-screen diagnostic system information
13. BNC connector: Female BNC connector for coaxial video

**The high resolution CCD camera shall meet or exceed the following specifications:**

1. Single Format: PAL
2. Scanning System: 2:1 interlace
3. Image Sensor 1/4-inch interline CCD
4. Effective Pixels: 752 (H) X 582 (V)
5. Horizontal Resolution: >460 TVL
6. Minimum Illumination: 3.0 lux
7. Synchronization System: AC line lock phase, V-sync
8. White Balance: Automatic with manual override
9. Shutter Speed: Automatic (electronic iris)/manual – 1/60-1/30,000
10. Gain Control: Automatic with manual override
11. Video Output: 1.0 to 1.2 volt peak to peak, 75 ohms, adjustable
12. Video Signal-to-Noise: >50 dB
13. Lens: F1.8 (F=4.2-42 mm optical) 10X optical zoom, 8X digital zoom
14. Zoom Speed (optical range): 1.5/2.5/4.3 seconds (selectable)
15. Horizontal Angle of View: 46.4° wide zoom, 5.0° telephoto zoom
16. Focus: Automatic with manual override

17. Iris Control: Automatic with manual override

**GENERAL:**

1. Top Cap: Anodized cast aluminum.
2. Dome Drive: ABS Plastic
3. Bubble: Acrylic
4. Environment: Indoor
5. Operation Temperature: 0° to 50°C
6. Certifications: FCC Class B, CE Class B.

**2.4 INDOOR FIXED DOME CAMERA SYSTEM**

- ❖ The integrated camera and lens shall consist of a standard resolution camera and fixed focal length lens as per site requirements.
- ❖ The integrated camera system shall be recessed mounting in ceiling.

**The DSP color CCTV camera shall meet or exceed the following specifications:**

1. Interline Transfer Imager: 1/3-inch interline CCD chip
2. Scanning System: 2:1 interlacing
3. Horizontal Resolution: 350 TV lines, PAL
4. White Balance: Automatic
5. White Balance Range: 2500 – 9500K
6. Iris Control Range: 1/60 to 1/100,000 second
7. Iris Control: Electronic/passive
8. Gain Control: Selectable by DIP switch (0-20 dB)
9. Minimum Illumination: 1 lux (f2.0)
10. Video Output: 1 Vp-p, 75 ohms
11. Signal-to Noise Ratio: 48 dB
12. Synchronize System: Internal or line lock
13. Backlight Compensation: Automatic or manual
14. Signal Processing: Digital signal processing
15. Input Voltage: 24 VAC line lock or 12 VDC, auto-sensing
16. Power Consumption: 3 watts or less
17. Video Output: 75 ohms terminated
18. Video Connector: BNC
19. Operating Temperature: 0° to 49°C
20. Dome: Polycarbonate, smoked
21. Certifications: CE Class B, UL Listed, FCC Class B, cUL

**2.5 INDOOR/OUTDOOR CAMERA WITH ENCLOSURE**

- ❖ The indoor/outdoor integrated CCTV camera and enclosure shall consist of a tamper/impact resistant, discreet, architecturally pleasing surface-mount enclosure with integrated fixed camera, lens, and low temperature resistor array.

**The tamper/impact resistant enclosure shall meet or exceed the following specifications:**

1. The enclosure shall be provided with a snap-on sun shield.
2. The enclosure shall be manufactured of aluminum.

3. The window material shall consist of optically clear, polycarbonate.
4. The enclosure shall be NEMA 4 and IP 66 rated.
5. The enclosure, with camera and integrated low temperature resistor array, shall be capable of operation down to  $-46^{\circ}\text{C}$ .
6. The enclosure, when installed, shall have no exposed cables.

❖ The integrated camera and lens assembly shall consist of a charge coupled device (CCD) camera with fixed focal length lens.

1. The CCD camera shall consist of 1/3-inch format interline transfer imager meeting PAL (CCIR) signal format specifications.
2. The camera shall be standard resolution color capable of 350 lines of horizontal resolution without iris.
3. The fixed focal length lens shall be provided as per site requirements.
4. The camera shall be 2:1 interlace and capable of AC line lock.
5. Two 9-pin plug-in mating connectors shall be provided to allow easy installation for either 12 VDC or 24 VAC input power.
6. Signal to Noise ratio shall be 48 dB.
7. Gain Control: Automatic
8. Minimum Illumination Sensitivity: 1 Lux (F2.0)
9. White Balance: Automatic

#### **2.6 1/3-INCH FORMAT, AUTO IRIS, VARIFOCAL LENS**

❖ The auto iris, varifocal lens shall come with a standard 4-pin plug installed, and it shall be appropriate for indoor and outdoor lighting situations.

**The auto iris, varifocal lens shall meet or exceed the following specifications.**

1. Type: Varifocal
2. Format Size: 1/3-inch
3. Mount Type: CS
4. Focal Length: 3~8 mm
5. Zoom Ratio: 2.7X
6. Relative Aperture (F): 1.0~360
7. Iris: Auto (Direct Drive)
8. Focus: Manual
9. Zoom: Manual
10. Diagonal View Angle:  $44.9^{\circ}\sim 117.9^{\circ}$
11. Horizontal View Angle:  $35.9^{\circ}\sim 91.0^{\circ}$

12. Vertical View Angle: 26.9°~66.6°
13. Minimum Object Distance: 0.2 m
  
14. Back Focal Length: 8.36~14.12 mm

## **2.7 MICROPROCESSOR-BASED, VIDEO MATRIX SWITCHING SYSTEM**

- ❖ The microprocessor-based, cross-point video matrix switching and control system shall consist of an external controller/CPU with integral ASCII control Interface, matrix input/output bay(s) and control keyboard(s) together with all software and graphics accessories necessary to comprise a complete operating video switching and control system.
- ❖ The matrix switching and control system shall include a PC programming/manager software package. The manager software shall be wizard-based, providing simple initial setup of the system as well as guided instructions on adding system devices, system operators, macro programming, and network setup. The system manager shall be capable of uploading and downloading of all system files to a 3.5-inch floppy drive making offsite programming capable. It must also be capable of performing live changes to the system without the need to take the system offline through an RS-232 interface. It must also have the ability to log all system user, fault, and automated system conditions such as alarms to provide an audit trail and reports.

### **The controller/CPU shall meet or exceed the following specifications:**

1. The control processor shall be PC based and feature an internal, Intel Pentium processor.
2. The controller/CPU shall include a VGA monitor output for display of system status of up to eight video monitors. System status shall include monitor number, currently addressed camera title and number, current alarms, and status associated with the current camera, as well as pan/tilt/lens and auxiliary functions status for the current camera being viewed.
3. The controller/CPU shall be provided with an internal 3.5-inch, 1.44 MB floppy disk drive with which to load/save setup information, previously input via the use of a standard PC, to configure and partition the system. Multiple setup configurations shall be possible by simple download to the controller/CPU via the internal 3.5-inch floppy disk drive.
4. The controller/CPU shall be provided with an internal 32 MB disk-on-chip system drive for storage of system setup parameters, operating system, and setup software.
5. The controller/CPU shall be equipped with a VGA graphics card providing separate VGA and PAL outputs and support screen resolutions of 1024 x 768 with 256 colors.

6. The controller/CPU shall provide for 16 RS-422 I/O ports.
7. The controller/CPU shall provide for 2 RS-232 ports, 1 parallel printer port, 1 VGA output port and 2 PC-AT compatible keyboard ports.
8. The controller/CPU shall provide for all communications to external devices such as matrix switching card cages, system keyboards, alarm interface units, pan/tilt devices, via standard computer based format such as RS-422, RS-485, or RS-232.
9. The controller/CPU shall provide for up to 96 definable users and passwords, keyboard entered, preventing unauthorized use.
10. The controller/CPU shall be equipped with an on-board ASCII translator allowing for direct communication with external equipment. The ASCII translator shall facilitate direct interface with computer-based access control systems and data systems.
11. The controller/CPU shall operate on either 230 VAC, 50/60 Hz.
12. The controller/CPU shall be rack mountable in a standard 19" rack.

**The matrix input/output bay(s) shall meet or exceed the following specifications:**

1. The matrix input/output bay(s) shall provide for all video input/output connections to the matrix switching system.
2. The matrix bay shall have a non-powered convection venting system that allows air to enter the front of the rack, pass through the matrix bay providing module cooling and even heat dissipation.
3. The matrix bay shall be modular in design with each bay providing eight high-density slots for input modules and two high-density slots for an output modules enabling expansion from 32 inputs and 16 outputs to 256 inputs and 32 outputs in a single matrix bay.
4. The matrix bay shall be 128 video inputs and 32 video outputs.
5. Multiple matrix bays shall provide interconnection, permitting expansion to 2,048 video inputs and 512 video outputs in a single CPU configuration.



6. Multiple nodes shall be capable of network connection and communication providing for peer-to-peer or peer to subordinate communication. Expansion is accomplished by adding matrix bay card cages, video input cards, video output modules, rear panel BNC cards, and additional networked controller/CPU's.
7. All modules shall have a heartbeat LED indicator that allows for a visual indication that the CPU on the module is running.
8. All modules shall have + and – power LED indicators allowing for a visual indication that the module power circuitry is operational.
9. The camera modules shall have a video loss LED indicator allowing for a visual indication if any of the video inputs on the module are not present.
10. The matrix bay(s) shall be capable of monitoring all video inputs for video loss without the need for any additional hardware or software.
11. The matrix bay(s) shall be capable of automatically reporting malfunctions to remote alarm monitoring equipment via an internal alarm output port.
12. The matrix bay(s) shall operate on 230 VAC, 50/60 Hz.
13. Matrix bay(s) communications to the system CPU shall be via RS-422, full duplex protocol.
14. The matrix bay(s) shall provide for vertical interval switching of properly phased inputs to all video outputs.
15. The system shall accept video input levels from 0.5 to 2.0 volts peak-to-peak, composite video signal, into 75 ohms.
16. The frequency response shall be flat to 8 MHz.
17. Bandwidth is 15 MHz+.
18. Cross talk shall be –60.9 dB at 3.58 Mhz.
19. Signal-to-noise ratio –71 dBrms.

## **2.8 KEYBOARD CONTROLLER**

**The keyboard controller shall meet or exceed the following specifications:**

1. The keyboard controller shall provide the main user interface to the matrix system and have control of all system functions, including auxiliary relays, receivers, camera/monitor switching, multiplexer screen functions.
2. The keyboard controller shall provide a total of five RJ-45 ports (two 8-pin RJ-45 female connectors for RS-422 connections, one 4-pin RJ-45 connector for RS-232 serial port connection, and two 6-pin female RJ-45 connector).
3. The keyboard controller shall provide for control of camera-to-monitor selection, camera/PTZ functions, alarm monitoring, and macro programming and operation.
4. The keyboard controller shall provide a variable speed, vector-solving joystick for pan/tilt/zoom control. All additional lens control functions shall be positioned next to the joystick for one-handed operation.
5. The keyboard controller shall provide easily accessible icons that open programming menus for on-the-fly programming changes.
6. The keyboard controller shall provide an adjustable, audible beeper to alert operators of all alarm conditions.
7. Each keyboard operator shall have a specific, unique, user-programmable password assigned to prevent unauthorized use.
8. The keyboard controller shall have a programmable, standard 10-digit numeric keypad and camera and monitor buttons for camera and monitor selection.
9. The keyboard controller shall feature 24 “soft” keys that can be programmed with the names of camera sites.
10. The keyboard controller shall provide an LCD display, which shall have adjustable back-lighting.
11. The keyboard controller shall feature multi-function keys to access programming icons and shall have multipurpose specialty keys for special functions.
12. The keyboard controller shall operate at 12 VDC from a 230VAC, 50/60 Hz input voltage power supply provided with the keyboard controller.
13. The keyboard controller shall consume no more than 400 mA and shall operate and communicate at distances of up to 4,000 feet on 24 gauge, twisted pair, shielded cable (standard RS-422).

**2.9 CODE DISTRIBUTION UNIT**

- ❖ The code distribution unit shall have two 8-position, RJ-45 parallel connectors to provide an input from a controller and an output for an additional daisy-chained Code Distribution Unit. The code distribution unit shall have sixteen 3-position screw terminal connectors to output 16 RS-422 transmit-only code lines and shall allow for star type wiring of PTZ data lines. The code distribution unit shall have standard 100-240 VAC, 50/60 Hz, line input, auto-ranging. The code distribution unit shall provide 16 driver outputs.

**The code distribution unit shall meet or exceed the following specifications.**

1. Input Voltage: 100-240 VAC, 50/60 Hz, auto-ranging or independent external source, 10-24 VAC/VDC
2. Data Ports Input: One RS-422, RJ-45 female connector
3. Data Ports Output: One RS-422, RJ-45 female connector
4. Drive Lines: Sixteen 3-position screw terminals with mating plugs.

5. Mounting: Fits 19-inch EIA-standard rack
6. Connectors:
  - Power: AC power cord input, 3-wire, 18 AWG
  - RS-422: Two RJ-45, female
  - RS-422 Breakout Ports: Sixteen 3-pin headers with mating plug.
7. Certifications: CE Class B, FCC Class B, Meets NEMA Type 1 standards

## **2.10 DATA MANAGER**

- ❖ The data manager shall allow the choice of one of three different operating modes: Keyboard Expander, Camera Control Expander, or Data Merger. The data manager shall allow connection of up to four keyboards to one data port. The data manager shall also allow for up to four matrix switchers, DVRs, or direct keyboards to share control of up to 32 PTZ cameras. Both RJ-45 connectors and screw terminals are provided for each data port. Diagnostic LEDs identify the amount of data activity for each port.

**The data manager shall meet or exceed the following specifications.**

1. Input Voltage: 230 VAC external adapter
2. Data Ports Input/Output: (5) RJ-45 connectors, (5) screw terminal connectors, (1) DB9 connector.
3. Connectors
  - Power: 9.0 VAC jack
  - Data Communication: RJ-45, screw terminals, DB9
4. Certifications: FCC Class A
5. Mounting: Fits 19-inch EIA-standard rack

## **2.11 MULTIPLE 24 VAC POWER SUPPLY**

All Indoor cameras shall be powered by one central power supply.

**The central power supply shall meet or exceed the following specifications.**

1. Multiple camera 24 VAC power supply unit and cabinet
2. 20-ampere capacity
3. Outputs for 16 cameras
4. Circuit Breaker protection
5. 220 VAC input
6. 24 VAC output or 28 VAC output for longer wire runs
7. UL and CE approval
8. AC power indicator with power on/off switch
9. Compatible with supplied cameras
10. Cabinet enclosure suitable for wall mounting

## **2.12 15-INCH HIGH RESOLUTION COLOR MONITOR**

- ❖ The 15-inch color monitor shall provide a high resolution picture; high quality; 100% steel housing; front panel controls; built-in speaker; connections for video and audio input/output, including separate Y-C connectors for S-VHS input.

**The color monitor shall meet or exceed the following specifications:**

1.	Diagonal Picture	14 inches
2.	Deflection	90°
3.	Standards	NTSC/PAL
4.	TV Lines of Resolution	Minimum of 700 horizontal TV lines
5.	Input Power Range	90-260 VAC, 50/60 Hz
6.	Wattage Consumption	Maximum of 95 watts
7.	Speaker	1.0 W (-3 dBV), built-in
8.	Comb Filter	Digital
9.	Color Switching	Automatic between NTSC/PAL formats
10.	Composite Video Voltage	1.0 Vp-p
11.	Synchronization	Internally derived
12.	Front Panel Controls	Tint, color, brightness, contrast, volume, and power on/off
13.	Connector Inputs	2 BNC inputs, 2 looping outputs, 1 DIN S-VHS
14.	Audio Inputs	2 RCA inputs
15.	Output Connectors	1 looping output
16.	Operating Temp. Range	0° to 41°C
17.	Operating Humidity Range	0% to 90% relative, non-condensing.
18.	Certifications	CE, Class B; UL; cUL; FCC, Class B

**PART 3 - EXECUTION**

**3.1** Wiring for each security system shall be carried out in separate conduit/ trunking to be installed in the manner specified by the system suppliers. The type of cables used for each system shall be strictly in accordance with the recommendations/requirements of the security equipment manufacturers to meet the specified performance. All cable conductors shall be of standard copper tinned throughout screened or unscreened as required.

**3.2** Co-ordinate with other trades for the installation of the system.

**3.3** The contractor /sub-contractor will be responsible for providing all access equipment necessary to enable safe installation of the system.

**3.4** The contractor will repair, correct or replace any defect of any nature that may occur for a period of 2 years from the date of issue of the certification of Completion.

**3.5** Contractor shall provide a full set of manuals and operating instructions. It shall include descriptive brochures, technical manuals for all equipments forming part of the contract.

**3.6** The Contractor shall provide necessary training to Client's personnel to give them on job training, instructions etc. for proper operating and maintenance of the system.

**END OF SECTION**

**SECTION 14750  
TELEPHONE SYSTEMS**

**PART 1**

**1.1 SUMMARY**

- A. Section includes arrangement with Telecommunications Utility Company for telecommunication service; payment of Utility Company charges for service installation.

**1.2 REFERENCES**

- A. Jordanian codes
- B. Local Utilities regulations
- C. EIA/TIA 568 (Electronic Industries Association/Telecommunications Industries Association) - Commercial Building Telecommunication Wiring Standard.
- D. EIA/TIA 569 (Electronic Industries Association/Telecommunications Industries Association)- Commercial Building Standard for Telecommunications Pathways and Spaces.
- E. NETA ATS (International Electrical Testing Association) - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

**1.3 SYSTEM DESCRIPTION**

- A. Service entrance from Telecommunications Utility Company.
- B. Telecommunications Utility Company
- C. Service Entrance Pathway: Empty ducts and raceway from point of Telephone Utility connection at property line to building service termination cabinet.
- D. Backbone Pathway: Conform to TIA/EIA 569 using conduits and sleeves or as indicated on Drawings.
- E. Horizontal Pathway: Conform to TIA/EIA 569, using racewayas indicated on Drawings.
- F. Entrance Wiring: By Telephone Utility Company.

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- G. Backbone Wiring: By Owner. Complete from entrance equipment to each telecommunications closet using unshielded backbone cables.
- H. Horizontal Wiring: By Owner. Complete from branch switch to each outlet using unshielded twisted pair horizontal cables and from telecommunications closet to each outlet using unshielded twisted pair cables.

### **1.4 SUBMITTALS**

- A. Product Data: Submit catalog data for each termination device, cable, and outlet device.
- B. Test Reports: Indicate procedures and results for specified field testing and inspection.

### **1.5 CLOSEOUT SUBMITTALS**

- A. Project Record Documents: Record actual locations and sizes of pathways , cabinets and outlets.

### **1.6 QUALIFICATIONS**

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years [documented] experience.
- B. Installer: Company specializing in installing products specified in this section with minimum three years experience ,and with service facilities within 100 miles of project.
- C. Testing Agency: Company member of International Electrical Testing Association and specializing in testing products specified in this section with minimum three years experience.

### **1.7 PRE-INSTALLATION MEETINGS**

- A. Convene minimum one week prior to commencing work of this section.

### **1.8 COORDINATION**

- A. Coordinate with utility company, relocation of overhead or underground lines interfering with construction. Where power lines are to be relocated, bill utility costs directly to Owner.

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- B. Contact utility company regarding charges related to service installation. Include utility charges in this contract.
- C. Utility charges for service installation paid by Owner and are not part of this contract.

## **PART 2 PRODUCTS**

### **2.1 TELEPHONE TERMINATION BACKBOARDS**

- A. Material: Fire retardant Plywood.
- B. Size: As indicated on drawings

### **2.2 TELEPHONE TERMINATION CABINETS**

- A. Product Description: Galvanized steel box with removable end walls, Furnish plywood backboard inside cabinet for mounting telephone termination devices.
- B. Cabinet Fronts: Steel, flush type with concealed trim clamps, concealed hinge, double doors, and flush lock keyed to match branch circuit panel board.

### **2.3 CROSS-CONNECT**

- A. Product Description: TIA/EIA 568, rack-mounted assembly of terminals with adequate capacity for active and spare circuits.

### **2.4 TELEPHONE OUTLET JACKS**

- A. Product Description: Conform to TIA/EIA 568 requirements for cable connectors for specific cable types.
- B. RJ11 outlets.

### **2.5 UNSHIELDED BACKBONE CABLE**

- A. Product Description: TIA/EIA 568, 100-ohm, unshielded twisted pair copper conductor.

### **2.6 UNSHIELDED HORIZONTAL CABLE**

- A. Product Description: TIA/EIA 568, 100-ohm, unshielded twisted pair cable with 4 pairs, 24AWG copper conductor.

## **PART 3 EXECUTION**

### **3.1 EXISTING WORK**

- A. Remove exposed abandoned telecommunications cables and pathways[, including abandoned cables and pathways above accessible ceiling finishes]. Cut flush with walls and floors, and patch surfaces.
- B. Disconnect and remove abandoned telecommunications equipment.
- C. Maintain access to existing telecommunications equipment, cabling, and terminations and other installations remaining active and requiring access. Modify installation or provide access panel.
- D. Extend existing telecommunications installations using materials and methods compatible with existing installations, or as specified.
- E. Clean and repair existing telecommunications equipment remaining or is to be reinstalled.

### **3.2 INSTALLATION**

- A. Install pathways in accordance with TIA/EIA 569.
- B. Install wire and cable in accordance with TIA/EIA 568.
- C. Finish paint termination backboards with durable enamel in accordance with Section prior to installation of telephone equipment.
- D. Install termination backboards and cabinets plumb, and attach securely to building wall at each corner.
- E. Install pull wire in each empty telephone conduit over 3 m in length or containing bends.
- F. Install engraved plastic nameplates. Mark backboards and cabinets with legend "TELEPHONE."
- G. Ground and bond pathways, cable shields, and equipment.

**END OF SECTION**