

JAPAN INTERNATIONAL COOPERATION AGENCY

THE GOVERNMENT OF  
THE HASHEMITE KINGDOM OF JORDAN  
THE MINISTRY OF TOURISM AND ANTIQUITIES  
THE MINISTRY OF PLANNING

DRAFT  
TENDER DOCUMENTS  
FOR  
CONSTRUCTION  
OF  
**DEAD SEA PANORAMIC COMPLEX SUB-PROJECT**  
THE TOURISM SECTOR DEVELOPMENT PROJECT

**VOLUME II**  
**SPECIFICATIONS**

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**TABLE OF CONTENTS**

**5SP-AS**

**DIVISION 1 - GENERAL REQUIREMENTS**

01100	Summary
01300	Administrative Requirements
01330	Submittal Procedures
01400	Quality Requirements
01500	Temporary Facilities and Controls
01700	Execution Requirements

**DIVISION 2 - SITE WORK**

02230	Site Clearing
02300	Earthwork
02540	Septic Tank Systems
02784	Stone Pavers
02900	Planting
02946	Landscape Edging

**DIVISION 3 - CONCRETE**

03050	Basic Concrete Materials and Methods
-------	--------------------------------------

**DIVISION 4 - MASONRY**

04810	Unit Masonry Assemblies
04853	Stone Assemblies

**DIVISION 5 - METALS**

05120	Structural Steel
-------	------------------

**DIVISION 6 - WOODS AND PLASTICS**

06200	Finish Carpentry
-------	------------------

**DIVISION 7 - THERMAL AND MOISTURE PROTECTION**

07120	Thermal and Moisture Protection
-------	---------------------------------

**TABLE OF CONTENTS**

**DIVISION 8 - DOORS AND WINDOWS**

08110	Steel Doors and Frames
08210	Wood Doors
08520	Aluminum Works
08800	Glazing

**DIVISION 9 - FINISHES**

09220	Portland Cement Plaster
09300	Tiles
09680	Carpet
09900	Paints and Coatings

**DIVISION 13 - SPECIAL CONSTRUCTION**

13000	Exhibition Work
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**APPENDIX A**

**TABLE OF CONTENTS****5SP-ME****DIVISION 15 - MECHANICAL**

15010	Basic Mechanical Requirements
15171	Electrical Requirements for Mechanical
15190	Mechanical Identification
15291	HVAC Thermal Insulation
15310	Fire Protection Piping
15311	Fire Protection Valves
15312	Fire Protection Supports, Hangers and Brackets
15320	Fire Pumps
15325	Fire Protection Systems and Equipment
15410	Plumbing Piping
15411	Plumbing Valves
15412	Plumbing Supports, Hangers and Brackets
15430	Plumbing Specialties
15440	Plumbing Fixtures
15450	Plumbing Piping Insulation
15451	Water Heaters
15452	Tanks
15500	Heating, Ventilation and Air Conditioning
15670	Condensing Units
15780	Packaged Air Conditioning Units
15856	Air Movers: Centrifugal and Axial
15890	Ductwork
15910	Ductwork Accessories
15996	HVAC Testing, Adjusting, and Balancing

**TABLE OF CONTENTS****DIVISION 16 - ELECTRICAL**

16010	Electrical General Provisions
16020	Electrical Service
16110	Race Ways
16115	Cable Trays
16120	Wiring
16122	600 Volt Cable
16125	Grounding
16130	Boxes
16140	Wiring Devices
16190	Metal Framing
16440	Switchboards-600 Volt & Below
16445	Panel Boards-Distribution & Below
16475	Fuses-600 Volt & Below
16490	Enclosed Safety Switches
16510	Lighting Fixtures & Lamps
16620	Packaged Engine Generator System
16622	Automatic Transfer Switches
16710	Fire Alarm System
16720	Sound System
16730	Telephone Systems Equipment
16735	Television Cabling
16745	TV/SAT & Video System
16746	AV/Video/Data Projection and Control Systems
16747	Conference System
16748	Simultaneous Translation System
16750	Security System

**DIVISION 15**  
**MECHANICAL**

## **BUILDING WORK**

### **DIVISION 15**

### **MECHANICAL**

#### **INDEX**

SECTION 15010	: Basic Mechanical Requirements
SECTION 15171	: Electrical Requirements for Mechanical
SECTION 15190	: Mechanical Identification
SECTION 15291	: HVAC Thermal Insulation
SECTION 15310	: Fire Protection Piping
SECTION 15311	: Fire Protection Valves
SECTION 15312	: Fire Protection Supports, Hangers and Brackets
SECTION 15320	: Fire Pumps
SECTION 15325	: Fire Protection Systems and Equipment
SECTION 15410	: Plumbing Piping
SECTION 15411	: Plumbing Valves
SECTION 15412	: Plumbing Supports, Hangers and Brackets
SECTION 15430	: Plumbing Specialties
SECTION 15440	: Plumbing Fixtures
SECTION 15450	: Plumbing Piping Insulation
SECTION 15451	: Water Heaters
SECTION 15452	: Tanks
SECTION 15500	: Heating, Ventilation and Air Conditioning
SECTION 15670	: Condensing Units
SECTION 15780	: Packaged Air Conditioning Units
SECTION 15856	: Air Movers: Centrifugal and Axial
SECTION 15890	: Ductwork
SECTION 15910	: Ductwork Accessories
SECTION 15996	: HVAC Testing, Adjusting, and Balancing

**SECTION 15010****BASIC MECHANICAL REQUIREMENTS****PART 1 GENERAL****1.01 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.

**1.03 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. Co-ordinated general arrangements of all services to a scale of not less than 1:100
  2. Co-ordinated detailed layouts of plant rooms and similar spaces to a scale of not less than 1:50.
  3. Schedules of all equipments and plant to be installed, together with start and running power consumption.



**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 Part 2	-	Special requirements for specific types of control 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
- 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 which 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 which shall be fabricated to form rigid trays with dust excluding gaskets around their perimeter.

Doors shall be fitted 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. For ac circuits.
- 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  $75 \text{ mm}^2$  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  $2.5 \text{ mm}^2$ .
- 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  $5^\circ\text{C}$  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, 60Hz 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 auto-transformer.
  4. Contacts rated at 15 starts per hour suitable for pushbutton operation, with magnetic blow outs 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 dash pot 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 starts per hour suitable for pushbutton operation, with magnetic blow-outs 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 blow outs 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 60 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.
  3. Motors shall be suitable for the starting methods specified.
  4. Motor starting currents shall not exceed the following values:-
    - Auto-transformer 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 downwards 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**

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 Electrical and Mechanical equipment shall be manufactured and installed 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 and Housing.
  - 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 Authority
  - 10. Electrical Regulations issued by JEPCO

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 : Karak  
Elevation : 1000 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.
- J. 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.
- K. All major stress-bearing forgings shall be made to a standard specification which 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 arranged for such forgings to be inspected at the place of manufacture with a representative of the Contractor.
- L. 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.
- M. 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 an 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 Contractor 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's 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 and 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 manufactured by the fan maker, of galvanised steel wire mesh, not greater than 25mm attached to a rigid galvanised steel rod framework.

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 which 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 of these Specification.
- 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 which 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 which 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.

- J. 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.
- K. The Contractor shall include for painting all pipes, ducts, flange edges, etc., prior to their being insulated.
- L. 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. A complete schedule of recommended oils and other lubricants shall be furnished by the Contractor. 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, a 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. Such tools shall not be used by the Contractor 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.
  - 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.
  - i) The Contractor shall include for the preparation and supply of six (6) 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**