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المؤسسة العامة للضمان الاجتماعي
Social Security Corporation

المشروع: انشاء مبنى ادارة فرع المؤسسة العامة للضمان الاجتماعي في محافظة الكرك

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SECTION 14200
ELECTRIC ELEVATORS

PART 1 GENERAL

1.1 INTRODUCTION:

The works include the design, supply, installation, maintenance and setting to work of the following passenger lifts L1, L2, (630) kg - (8) persons (4) stops (B2, B1, GF, 1ST).

1.2 SCOPE OF WORK

1.2.1 This specification covers the functional and technical requirements for supplying and installing Lift system complete in accordance with the requirements of the contract documents, which shall include, but not be limited to the following:

A. Details in schedules.
B. Details on drawings.
C. Details in bills of quantities.
D. Details in of specifications and standards.
E. The finishing should be supplied and installed also with the same package.

1.2.2 Related work specified elsewhere and not forming part of this section (except if it is mentioned in the B.O.Q of the lifts then it will be part of the works): Related electrical and mechanical installations are specified elsewhere in other Divisions of the specifications and the contractor shall co-ordinate these works with the lift System installations and with all other works. In addition, the following works are specified elsewhere:

A. Protection of hoist-way entrance head and side jamb. With plywood after installation while construction work is in progress.
B. Installation of electrical power supplies, lighting, Socket outlets smoke detectors and data on the top shaft with supply power feeders.
C. Permanent lighting fittings with switches and grounded receptacles in each lift System shaft.
D. Electric power of permanent characteristics for installing, testing and adjusting the System equipment.

1.2.3 The contractor is requested also to follow the following instructions:

A. Scope of work includes **design, supply, installation, testing commissioning & and maintaining of passenger elevators for 2 years labor, parts and complete technical supports.**
B. Scope of work should include all finishes of elevators cabins.
C. Any deviation in the submittal from specified capacities, speeds, dimensions etc... Should be clearly highlighted in the shop drawings for prior approval.
D. Shaft sizes as mentioned in the documents cannot be modified.
E. Any submittal should be under the warrantee of the mother company at the main approved manufacturer office.
F. Spares for all elevators will be available for (15) fifteen years.
G. The contractor should be able at commissioning time to secure approval and meet requirements of **Jordan Standards and Metrology Organization.**

1.3 SPECIFICATIONS, REGULATIONS, CODES ETC.

The lifts, which shall installed, must comply with the following requirements:

A. Special technical specification includes:
   1. Introduction.
   2. General terms.
   3. Lifts particulars.
   4. Lifts technical specification.
   5. Bill of quantities.
   6. Installation characteristics and origin of parts (to be completed by the tenderer).

B. EN-81 and all following European standards EN81-up to 2023.
   1. EN 81-21:2022. EN 81-50:2020 sets out revised and updated safety requirements for the construction, installation and accessibility of elevators.
   2. EN 81-50:2020, defines the test and examination requirements for certain elevator components.
   3. Elevator Code: Comply with applicable requirements of the "American Standard Safety Code for Elevators, (ANSI A17.1) published by the American Society of Mechanical Engineers.
   4. ASME A17.1-2010, Safety Code for. Elevators and Escalators. Safety Code for Elevators. 2010 Edition.
   5. Fire Resistance of Entrances: Comply with NFPA No-80.
   6. DD197 - Recommendations for Vandal Resistant Lifts.
   7. EN81-71 Vandal Resistant.
   8. Fire rated EN81-58/E120.
   9. EN81-70:2018 standard defines elevator control, distance, dimensions, contrasts and accessories that facilitates access for people using wheelchairs or walking aids.

C. Civil Defense regulations and recommendations.
D. Drawings.
E. Service and maintenance.
F. **Jordan Standards and Metrology Organization.**

In all cases, the requirements of the Technical Specifications take priority over the requirements of the General Specifications

1.4 TENDER TERMS

1.4.1 The Contractor shall specify the trademark country of origin of the equipment to be supplied including all parts.

1.4.2 The Client reserve the right to reject, without any further explanation, any Contractor who does not comply with the requirements of the specification AND the standards above or does not have the necessary experience for a job of this scope. Without detracting from the above conditions, the lift Contractor should have a representative in Jordan, approved by the Standards Institution of Jordan Country.

PART 2: GENERAL TERMS

2.1 CONSTRUCTION DOCUMENT

2.1.1 Program

1. The Contractor shall carry out and complete the contract works in accordance with the "Master Program" prepared by Main-contractor and reasonable in accordance with the progress of Main Contract Works.
2. In addition to providing program information required for the client, the contractor shall prepare and submit, through the contract, a schedule detailing his own works so that the Site Engineer can identify the primary activities and show in respect of every major portion of contractor words, the latest dates appropriate to the following events:
   A. For receipt from other contractors all information necessary to enable the contractor to prepare installation drawings, diagrams and schedules. For delivery to the Main-contractor of installation and other drawings, diagrams and schedules showing positioning and fixing of services and associated builder's work of anon-structural nature so that the Main- contractor may co-ordinate them prior to submission to the Site Engineer for examination.
   B. For return to the Main-contractor of the drawings, diagrams and schedules included in the previous paragraph consistent with the time required for examination.
3. Any comments made by the Site Engineer on the program shall not relieve the contractor of his obligations to execute and complete the contract works in conformity with the reasonable directions and requirements of client.

2.1.2 Builder's Work and Drawings

1. Where builder's work is to be formed, drawing shall be provided.
2. Where access holes or panels are required for commissioning routines or post-contract maintenance, drawings shall be provided.
3. Where builder's work is to be cut, it shall be marked on site.
4. The Contractor for submittal shall make a preliminary issue up to three copies of all such drawings and information to client.
5. Up to three copies of each drawing, the contractor for final distribution shall supply diagram or schedule.
6. The Contractor will be responsible for the accuracy of the information he provides and will be liable for all costs arising from any errors in such information.

2.1.3 Installation Drawing Diagram and Schedules

1. The contractor shall prepare or shall cause his specialist suppliers and sub-contractors to prepare all necessary drawings, diagrams and schedules for the following purposes:
   a. To illustrate in detail the arrangement of the various sections of the contract works and to identify or describe the various components.
   b. To integrate the contract works properly with the detail of the building and with the work of other trades and other services installation.
   c. To furnish to other trades such information, as is the responsibility of the contractor to provide.
   d. To locate and identify all necessary test points, access positions or other Provisions for the commissioning routines.
2. While it shall remain the responsibility of the contractor to identify and provide full and detailed installation drawing, the following is a guide to the categories, which will be required:
   a. General arrangement drawings showing detailed layout of lift wells openings.
   b. Detail of landing entrances.
   c. Details of holes required for all devices including landing buttons, position indicators and hall lanterns.
   d. Section through lift wells showing positions of built in fixing devices.
   e. General arrangement drawings of all plant and equipment, switch and distribution broads etc. showing the positions of the equipment and of associated ancillaries, trunking, racking and cable contentions etc. to a scale of not less than one twentieth full size.
3. A preliminary issue of up to three copies of all such drawings, diagrams and schedules shall be made to the contractor, for examination by the client in good time and in no case less than 28 days before they are required by the Main-contractor for final distribution.
4. Up to three copies of each drawing, the contractor for final distribution shall supply diagram or schedule.
5. The contractor shall be responsible for the accuracy of the he provides and shall be liable for all costs arising from any errors or delays in such information.

2.1.4 RECORD DOCUMENT

1. The contractor shall supply to the Engineers, as pre-requisite to practical completion of the contract works, comprehensive record document in uniform indexed bound sets. The contractor is advised that great importance will be placed upon the quality, accuracy, clarity and completeness of the record documents and upon their being made available promptly.
2. The contractor shall demonstrate from time to time as required by the Engineers throughout the execution of the contract works, that adequate and accurate records are being kept such as will ensure the ultimate completeness and

accuracy of the record documents and that record documents are themselves being progressively compiles as the word on site proceeds.

3. Scope of Record Documents:

3.1 Record documents shall comprise all as described in this specification, the following:

a. Record drawings and schedules.
b. Operating and maintenance instructions in duplicate.

3.2 Upon completion of the work as a complete set of negatives and four sets of prints of all drawings shall be handed to the contractor showing the new installation as finally installed with detailed dimensions and all relevant information that may be necessary for future maintenance etc. together with any variations from the original made during the course.

3.3 In order to produce these drawing as soon as the installation is completed and to ensure their accuracy the Sub-contractor shall keep on site a complete set Prints, bound together of all installation drawings. At frequent period the prints shall be marked to indicate clearly all runs of conduit, etc. as actually installed including any variations to the original contact drawings. The prints will be inspected during the course of the work to ensure that this requirement is being carried out.

3.4 The record documents shall be adequate for the followings purposes:-

a. To record clearly the arrangement of the various sections of the contract works as actually installed and to identify and locate all component parts thereof.
b. To make it possible to comprehend the extent and purpose of the contract works and the method of operation thereof.
c. To set out clearly the extent to which maintenance and servicing is required and how, in detail, it should be executed.
d. To provide sufficient and readily accessible information to facilitate the ordering of spares and replacement.

4. The record document shall be correlated so that the terminology and the numerical and/or other references used therein are consistent with and similar to those used in the physical identification of component part of the contract works.

2.1.5 Record Drawings and Schedules

1. The record drawings provided by the contract, shall comprise the documents listed in the following paragraphs, as applicable. All such documents shall clearly be endorsed RECORD DRAWING near to the title block.
2. Drawings or sets of drawings to a suitable scale, which shall show the "as fitted" location of the following:
   a. The general arrangement of the lifts installation.
   b. Details of shafts, wells, pits etc.
   c. Length, sizes and all other details of all ropes.
3. Comprehensive diagrams of sets of diagrams, which shall show:
   a. All main and control circuits including size, type of conductor and terminal point of each.
   b. The principles of operation of each control system.

2.1.6 Operating and Maintenance Instructions

Operating and maintenance instructions shall be provided by the contractor and shall comprise the following, as applicable (all contained in volumes sternly bound in flexible covers and suitable for heavy usage over a long period) written to be read in conjunction with the record drawings:

a. A general description of scope, purpose and manner of working of each lift unit forming part of the contract works.
b. A detailed description of scope, purpose and manner of working of each system

of controls.

c. Date on general design parameters together with manufacturer' information, concerning correct operation etc. based on the commissioning activity.
d. Clear and comprehensive instructions for the switching on operation and closing down of each unit.
e. Clear and comprehensive instructions for dealing with emergency conditions for each unit.
f. Instructions in respect of any other precautionary measures from time to time necessary.
g. Instructions in respect of the care of apparatus are normally subject to seasonal disuse.
h. Instructions as to the nature, extent and frequency of servicing necessary properly to maintain the lift in good condition and as to the materials to be used for the purpose.

2.2 PROGRESS REPORTS

The Contractor shall provide information on the progress of the work to the Engineer upon his request. The Contractor shall maintain a log in which he shall record the work, problems and important data relevant to the job. The Engineer is entitled to review the above-mentioned log at any time.

2.3 CONSTRUCTION WORK

2.3.1 Dimensions

The Contractor (must) shall check all dimensions on site and shall not rely on the construction drawings only.

2.3.2 Additional Contractors

Other contractors shall be present at the site. The Contractor, who is awarded this job, shall work in close cooperation and in full coordination with these parties.

In the event of mutual disagreements / interference / claims and the like, the matter shall be submitted to the Engineer, and its decision shall be final and binding upon the Contractor.

The Contractor shall not be entitled to any payment whatsoever for the coordination and cooperation with these other parties.

2.3.3 Work Executed by Contractors

The following items of builder work will be carried out by Contractors in accordance with approved drawings prepared by the Engineer.

1. Formation of lift shafts and pits.
2. Application of dust inhibiting solution to the lift shafts.
3. Cutting away and making good of floors, walls and ceilings in the fabric of the building.
4. Back filling and making good around architraves, sills, push buttons and indicators etc. including adequate shoring to prevent distortion.
5. Provision and fixing of temporary removable screens at each landing entrance.
6. Prepare all openings according to contactor drawings.

2.4 ELECTRICITY

For all lifts:

The electricity Contractor shall supply a three-Phase, 400 Volt, 50 Hz power line and ground and a single-phase 230 Volt for power and lighting for the lift shafts. In addition, the contractor shall supply circuit breakers suitable for the above mentioned power supplies.

All connections and devices beyond these circuit breakers shall also be implemented by the Contractor and shall comply with the Standard and with the requirements of the local regulatory bodies.

The electricity Contractor shall supply lighting, a single-phase outlet and an emergency lighting fixture in the lifts shaft site.

2.4.1 Electricity for the Contractor's Work

The electricity Contractor shall supply electric current required for his works at any location on the site. Connection to this power source shall be the responsibility of the Contractor.

2.5 QUALITY OF THE WORK

The Contractor undertakes to implement the work to the highest standard and according to existing and accepted regulations, laws and Standards. The work shall be executed by a sufficient number of highly qualified workers suitable for the work.

The Contractor shall supply materials, facilities and instrumentation required for the work. All materials and parts shall be new and of the highest quality.

No work of any kind shall be assigned to a subcontractor without the prior written approval of the Engineer.

The Engineer is entitled to reject any subcontractor which, in its opinion, does not properly execute the work.

2.6 DAMAGE TO THE BUILDING

The Contractor shall be responsible for any damage that may be caused to the building, the machinery, the facilities and persons by it or by its employees or by a defect in the materials supplied by it or a result of unprofessional or faulty work, either directly or indirectly. The Contractor shall be required to compensate the Client for the full extent of the above damages.

No cutting into the structure, beams or columns may be implemented without prior written approval by the Engineer. The Contractor shall be required to submit suitable insurance which shall constitute full security against damages which may be caused to persons, materials, facilities and equipment, by any cause whatsoever, including flood, fire, electrical short or electrical current, etc., within the scope of its work. The Contractor shall also provide insurance for its employees and any third party. The Contractor shall submit a copy of the policies to the Client.

2.7 ADDITIONAL WORK

The execution of any work or the supply of any materials not included in the "Bill of Quantities" or in the technical description requires the prior written approval of the Engineer.

The contactor THROGH THE SUPPLIER must provide the owner with a full detailed technical specification shown in the purchase order (PO) documents FROM THE MANUFACTURER FACTORY.

2.8 ASSEMBLY OF THE SYSTEM

The Contractor shall implement the work by means of highly competent professional workers, directly supervised by experts and foremen. In addition to all the principal parts.

The Contractor must provide all auxiliary and other materials, labor, instrumentation, lifting devices and accessories required for professional work of the highest quality.

The Contractor shall be responsible for all cartage and porterage required to execute the work.

2.9 ACCEPTANCE

2.9.1 After completing the installation and commissioning of the lifts, the Contractor shall arrange the following tests, at their own expense, and shall submit verification that the tests were implemented as proof that the work was executed correctly.

Should any of the tests detect faults, defects, or any requirement for repair of completion of the work, the Contractor shall fulfill the requirements of the following entities to the extent that they are within the scope of its work:

a. The Jordan Electric Corporation.
b. Jordan Specifications and Measurement Department.

In addition to the tests required by international Standards, the following tests shall be carried out:

a. The lifts shall be tested with 10% overload for one complete journey in the round trip travel time.
b. Note: The primary object of this overload test is to ensure that the motor in particular – with suitable increase in current – is capable of handling a reasonable overload.
c. The lift shall be operated at full speed for thirty minutes continuously with the full rated load (except for reversal of direction at terminal floors).

The Contractor shall provide all test weights and all necessary instruments.
Dates of tests shall be notified by the Contractor giving the Engineer not less than seven days' notice, in writing, to enable the Engineer to arrange for the tests to be witnessed.
Note: After the above tests are completed, the overload protection shall be re-set for the specified contract load.

2.9.2 The Contractor shall submit three copies (3) of the following documents to the Engineer after the tests have been implemented:

a. The results and approval of the tests.
b. "As Built" drawings, including detailed mechanical, electrical and control drawings, and maintenance instructions.

After the above documents have been submitted, the lifts shall be delivered to the Client in the presence of the Engineer who shall inspect the lifts for compliance with the Technical Specifications.
The Contractor shall provide all accessories and personnel required to implement the inspection.

Should any discrepancies or faults be discovered, the Contractor shall correct them immediately. The final delivery of the facilities shall take place after all required repairs have been made.

2.2 TRAINING

The Contractor shall train the client's maintenance staff, as part of the delivery, in the proper use of the lifts in "first aid" and rescue operations in the event of power failure or other breakdowns.

The supplier/contractor should include in his proposal a visit to the factory of which the supplier is providing his offer from for two electrical engineers from the owner side and one engineer from the consultant's side to conduct the technical meetings and witness the factory acceptance tests and inspect the lifts assembling and materials in accordance to project master bid documents, please note that all expenses are covered under the EPC contract.

2.3 SIGNS

The Contractor shall affix all of the signs required in the compartment and at the entrances, signs indicating the permitted load as well as operating and rescue instructions as required by the Standard.

All devices associated with rescue operations (handles, wheels, main breakers, etc.) shall be painted in red.

In addition, cables shall be marked corresponding to their position when the respective lift stops at each floor.

FPART 3: LIFTS SPECIFICATIONS

3.1 LIFT TECHNICAL SPECIFICATIONS

3.2 PASSENGER LIFTS (L1, L2):

LIFT ORIGIN:	MUS BE ONE FULL PACKAGE OF ONE. SOURCE
QTY. OF LIFTS	(2) LIFT / DOUPLEX SYSTEM.
CAPACITY	(630) KG.
SPEED: (VVVF)	1.00 M/S.
CONTROL	VVVF - Variable Voltage Variable Frequency drive.
NO. OF FLOORS:	4 FLOORS.
FLOORS DESIGNATION:	FRONT B2, B1, GF, 1^{ST}.
SHAFT SIZE:	1800 mm (W) X 2100 mm (D).
PIT:	AS PER DRAWINGS.
HEAD ROOM:	AS PER DRAWINGS.
MACHINE ROOM LOCATION:	THE MACHINE IS ROOMLESS AND THE CONTROL PANEL SHALL BE IN THE ROOM ON ROOF.
POWER SUPPLY:	AC 3- PHASE, 400 VOLTS, and 50 HZ

3.3 CONTROL SYSTEM:

THE CONTROL SYSTEM SHOULD BE BASED ON MICROCOMPUTERS AND SERIAL TRANSMISSION TECHNOLOGY, THROUGH AN ENTELLIGENT COMMUNICATION NETWORK.

THE CONTROL MUST HAVE THE FOLLOWING FEATURES:

- NOISE FILTER
  - ✓ INSPECTION DRIVE
  - ✓ DIGITAL DISPLAY FOR LIFT EFFECTS
- CURRENT TRANSFORMER ON EACH MAIN PHASE FOR (V.V.V.F.).

THE CONTROL SHALL INCLUDE THE FOLLOWING FEATURES:

1. ADJUSTABLE TIMER SYSTEM FOR CABIN LIGHTING AND FAN SHUT OFF.
2. EMERGENCY EVACUATION SYSTEM WITH BATTERY (ARD).
3. Load by-pass.
4. Automatic Car Return Device.
5. Anti-Nuisance Device.
6. Nudging Feature.
7. Door Time Protection.
8. Emergency Fire Device.
9. Electrical Recall Operation.
10. Emergency Rescue Device
11. Emergency Power Operation.

12. Load Non-Stop Device.
13. Over Load Device.
14. Sound system to announce arriving floors NO.

THE CONTROL SYSTEM SHOULD FOLLOWING PROTECTIONS:

1. No-Volt and sustained under-voltage
2. Remote monitoring and diagnostics.
3. Phase reversed of the power supply
4. Overload, over current, over voltage.
5. Failure of any phase.
6. Over current in any component.
7. Earth leakage protection.
8. Serious unbalance of phase winding current
9. Heat sinks temperature.
10. Automatic fire returns system.
11. Full load by pass.

3.4 MODE OF OPERATION:

DUPLEX FULL COLLECTIVE SELECTIVE SYSTEM IN UP & DOWN DIRECTIONS.

3.5 DRIVE SYSTEM:

THE DRIVE SYSTEM FOR EACH LIFT SHALL BE THREE PHASE PERMANENT MAGNET GEARLESS DRIVE SYSTEM, OUTPUT POWER TO BE ACCORDING TO MANUFACTURER STANDARD.

- PROTECTION CLASS (IP21).
- INSULATION CLASS (F).
- HEAVY –DUTY MACHINE WITH (180) START/HOUR FOR DOOR SYSTEM.

DRIVE & CONTROL SYSTEM WITH (VVVF) MUST BE OF ONE SOURCE (OPERATION IN HARMONY).

3.6 CABIN:

- **FRONT**, **SIDE** & **REAR WALLS** TO BE CONSTRUCTED FROM ANTI MAGNET AISI 316 GRADE 1.5mm THICKNESS TO BE ACCORDING TO CUSTOMER REQUIREMENTS CHOOSABLE FROM COMPANY CATALOGUES.

  ✓ CABIN DIMENSIONS WILL BE ACCORDING TO MANUFACTURER STANDARD FOR REQUIRED CAPACITY AND SHAFT DIMENSIONS.

  ✓ CABIN FINISHES TO BE ACCORDING TO CUSTOMER REQUIREMENTS.

  ✓ CABIN MUST CONTAIN THE FOLLOWING FEATURES AND FINESHES:

- BUILT – IN POLISHED STAINLESS STEEL MIRROR ON THE UPPER HALF OF THE REAR WALL: **EN-81-71 Cat1 COMPLIANT**.
- MARBLE CABIN FLOOR
- STAINLESS STEEL HANDRAILS ON TWO SIDES CHOOSABLE FROM COMPANY CATALOGUES.
- STAINLESS STEEL FALSE CEILING CHOOSABLE FROM COMPANY CATALOGUES.
- RECHARGABLE EMERGENCY LIGHT (TO SWITCH OFF AFTER LIMITED TIME).
- INTERCOM (3-WAY SYSTEM).
- LED LIGHTING FIXTURE.
- TWO BLOWER SILENT FANS (TO SWITCH OFF AFTER LIMITED TIME).

- ACUSTIC AND LUMINOUS OVER LOAD SYSTEM.
- FULL LOAD SYSTEM.
- EMERGENCY EXIT ON THE TOP OF THE CAR.
- SAFETY BALUSTRADE ON CAR TOP.
- ARRIVAL GONG.
- FIXED CONNECTION BOX AT TOP OF THE CAR TO INCLUDE:

  - ✓ MAINTAIN NORMAL – REVISION SWITCH
  - ✓ UP BUTTON
  - ✓ DOWN BUTTON
  - ✓ STOP BUTTON
  - ✓ OUTLET SOCKET AND LAMP

- CAR OPERATING PANEL : (C.O.P)

  - ✓ TO BE CHOOSABLE FROM COMPANY CATALOGUES, ALL USED BUTTONS MUST BE HEAVY DUTY FULLY MUST COMPLY WITH EN-81-71 vandal resistance standard, CAR OPERATING PANEL MUST INCLUDE:

  - ✓ FLOOR BUTTONS NO. OF FLOORS (4) DESIGNATION : B2, B1,GF,1
  - ✓ DOOR OPEN BUTTON
  - ✓ DOOR CLOSE BUTTON
  - ✓ INDICATOR WITH DIRECTION ARROWS.
  - ✓ FANS BUTTON / SWITCH
  - ✓ ALARM BUTTON
  - ✓ INTERCOM BUTTON
  - ✓ OVER LOAD INDICATOR
  - ✓ FIRE INDICATOR
  - ✓ INSTRUCTION PLATE IN ARABIC & ENGLISH LANGUAGE.
  - ✓ PRIORTY KEY SWITH (VIP).
  - ✓ ALL BUTTONS MUST BE BRAILLE-LABELED BUTTONS.
  - ✓

3.7 CABIN DOOR:

AUTAMATIC TWO PANELS **CENTRAL OPENING** SLIDING DOOR CONSTRUCTED FROM ANTI MAGNET AISI 316 GRADE 1.5mm THICKNESS TO BE ACCORDING TO CUSTOMER REQUIREMENTS CHOOSABLE FROM COMPANY CATALOGUES.

- ✓ CLEAR DOOR SIZE: 900 mm (W) X 2100 mm (H).
- ✓ CABIN DOOR TO INCLUDE FULL HEIGHT PHOTOCELL.
- ✓ CABIN DOOR OPERATOR MUST BE HEAVY DUTY.
- ✓ ADJUSTABLE SPEED FOR OPENING AND CLOSING VIA V.V.V.F. OR D.C. CONTROL.

3.8 LANDING DOORS:

AUTOMATIC TWO PANEL CENTRAL OPENING CONSTRUCTED FROM ANTI MAGNET AISI 316 GRADE 1.5mm THICKNESS TO BE ACCORDING TO CUSTOMER REQUIREMENTS CHOOSABLE FROM COMPANY CATALOGUES.

- CLEAR DOOR WIDTH = 900 mm
- CLEAR DOOR HEIGHT = 2100 mm

ALL DOORS MUST BE FIRE RATED AT LEAST 1.5 HOUR.

3.9 LANDING PUSH BUTTONS:

ONE LANDING STATION TO BE FIXED BETWEEN TWO LIFTS.
TWO BUTTONS ON EACH STATION TO BE FIXED AT INTERMEDIAT FLOORS, AND ONE BUTTON AT TERMINAL FLOORS.
LANDING STATION AT MAIN FLOOR TO CONTAIN FIRE KEY SWITCH.
ALL LANDING BUTTONS TO BE CHOOSABLE FROM COMPANY CATALOGUES.
ALL BUTTONS MUST BE BRAILLE - LABELED BUTTONS.

3.10 INDICATORS AND ARROWS:

INDICATORS WITH DIRECTION ARROWS TO BE FIXED ABOVE EACH LANDING ENTRANCE, ALL INDICATORS AND ARROWS TO BE CHOOSABLE FROM COMPANY CATALOGUES.

3.11 COUNTER WEIGHTS:

STEEL PROFILE FRAME WITH CAST IRON FILLERS TO BALANCE THE CAR WEIGHT WITH 45-50% OF THE LIFT RATED CAPACITY, INSTALLED AT REAR.

3.12 ELEVATOR MACHINES AND EQUIPMENT

Power Control: Except as otherwise indicated, where variable-voltage is required, provide manufacturer's standard solid-state power converters, for use with manufacturer's motors on elevator machines

Motors, Controllers, Machine Brakes, …Etc.: Provide motors, controllers, machine brakes, buffers, guide rails, ropes, bedplates, isolation mounts and other machinery as recommended by the manufacturer and that are suitable for the intended installation and approved by the Engineer

Inserts: Provide required concrete inserts and similar anchorage devices for the installation of guide rails, machinery and other components of elevator work.

Guide Shoes: Unless otherwise indicated, provide manufacturer's standard units.

Car Frame and Platform: Manufacturer's standard welded steel units

3.13 OVER SPEED GOVERNORS:

TO BE INSTALLED AT THE TOP OF THE SHAFT, OVER SPEED GOVERNOR MUST WORK AT LIFT NOMINOL SPEED, AND ADJUSTED AT THE TRIPPING SPEED IN ACCORDANCE TO ACCEPTED CODES

3.14 SUSPENSION ROPES:

SPECIAL STEEL ROPES FOR LIFTS WITTH A STRENGTH OF NOT MORE THAN 160 KG/MM2 HAVING A SEAL STRUCTURE 19X8 WITH A SUITABLE NUMBER AND DIAMETAR .

THE ROPES ENDS SHALL HAVE ZINC BELLS OR ROPE CLAMPS. SAFETY FACTOR TO BE NOT LESS THAN (12).
STEEL WIRE ROPES OR POLIURETHANE-COATED BUILT ARE ACCEPTED.

3.15 GUIDE RAILS:

CAR AND COUNTER WEIGHT GUIDE RAILS SHALL BE MADE OF COLD DRAWN HIGH QUALITY STEEL T- SECTION.
BUCKLING CALCULATIONS TO BE SUBMITTED UPON ENGINEER REQUIST.

3.16 GUIDE SHOES:

SPECIAL SLIDING HEAVY DUTY GUIDE SHOES FOR CAR AND COUNTERWEIGHT.

3.17 BUFFERS

RUBBER OR SPRING BUFFERS TO BE FIXED UNDER CAR AND COUNTERWEIGHT IN THE SHAFT PIT.

3.18 RAVELLING CABLES:

SPECIAL FLAT FLEXIBLE TYPE CABLES, TO BE SUPPORTED AND PROTECTED, AND TO COMPLY WITH THE RELEVENT STANDARDS.
CABLES CONNECTIONS IN THE LIFT SHAFT DUIRING INSTALLATION IS NOT PERMITTED.
TRAVLLING CABLES MUST INCLUDE ADDITIONAL LINES FOR CCTV AND SOUND SYSTEMS.

3.19 General characteristics:

Safety:

- ✓ Safety gear shall be instantaneous type with buffered effect.
- ✓ Electrical safety switches in the safety Governor Mechanism and cabin.
- ✓ Car door and landing doors shall be provided with mechanical and electrical inter-lock device to interrupt operation of lift when doors are not completely closed.
- ✓ An electronic detector shall be provided extending the full height of the front edge of the car door panels.
- ✓ An overload safety device shall be provided with audible buzzer and a display in car operating panel.

FPART 4:DETAILD SPECIFICATIONS FOR LIFTS MAIN PARTS

4.1 LIFT CAR – GENERAL

Suitable dimensions for safe working load.

4.1.1 STRUCTURE: Firm car accommodated within a solid frame of profiled metal, reinforced according to load and operating conditions below.
The car is isolated from the suspension frame by rubber cushions or any other material suitable for preventing transmission of vibrations. A rope suspension mechanism, car shoes, a safety device, a moving cam mechanism and a door operator are mounted on the frame.
A weighing device should be provided, having a resolution of not more than 50 kg. (A weighing system equipped with rubber pads under the traction machine will not be accepted).
On the lower section, along the entire length of the car’s opening, a panel, at least 750 mm high must be installed, with its lower section slanting backwards.

4.1.2 CAR WALLS: CONSTRUCTED FROM ANTI MAGNET AISI 316 GRADE 1.5mm THICKNESS stainless steel sheet elements is required as per the Engineer discretion. The car shall also have handrails made of stainless steel profile around the walls, and a decorative panel around the floor, as per the Engineer's discretion.
The front of the car and the car doors are made of stainless steel. The floor of the car should be covered with marble, or granite, as per Engineer's discretion.
The exterior of the car should be entirely coated with a special resin to prevent noise during travel (anti drum).

4.13 CAR CEILING: shall be painted with white, oven dried paint. The ceiling shall have an emergency exit with one flow and one exhaust fan, or compatible, with an integral switch supplied via the relay control power supply line. Operation of the fans shutting off by key switch same as the automatic illumination.
The ceiling of the car shall comprise indirect illumination or a double ceiling with a false ceiling made of aluminum or any other suitable material, or depressed illumination with bulbs as required by the Engineer. Car design must be approved by the Engineer prior to manufacture.

4.2 SHAFT DOORS

Automatic sliding doors for each opening (dimensions according to lifts specifications), made of anti-magnet stainless steel sheet CONSTRUCTED FROM ANTI MAGNET AISI 316 GRADE 1.5mm THICKNESS stainless steel.
Each door must be able to be opened from the outside, using a special key.

4.3 CAR AND SHAFT DOOR OPERATOR

The car and shaft doors shall be linked and shall operate simultaneously, during closing and opening, by means of a suitable mechanism.
The car and shaft doors shall open automatically when the car is at a stop. Closing the car and shaft doors should occur before the car can be moved. The doors should be silent for closing and opening.
It should be possible to stop door operation and reverse direction while closing. Each door shall be provided with an integrated device for preventing the car from leaving a stop while suitable contacts shall be provided for door control, as required by law. Door operator assembly shall comprise a motor, a pinion or worm gear, jointed arms, wheels, bearings, locks and contacts and shall be manufactured by the parent company of the lift supplier. The doors shall travel over polished rails, by means wheels with ball bearings and a lower rail made of aluminum, matching the car floor.

The mechanism shall include an opening system, comprising a full height photoelectric eye and an opening device crossing the light beam, or applying a force of more than 15 kg on the door, shall cause the door to retract, and after a delay, to close again.

(Press of door close button shall reduce door delay, causing it to close immediately).

The doors shall open manually for their entire width (in an emergency) without the application of more than reasonable force.

A heavy duty door operator is required with a retractable safety edge and adjustable speed.

Full height photocell shall be positioned on the entrance of cabin.

The lift shall park at stops with closed doors, (except for main floors). Pressing an external call button, while the lift is at the same stop shall cause doors to open. If after a close door command no lock contact is made, the door shall re-open and attempt closing after a delay.

After three attempts the door shall open, and shall remain open, and existing calls shall be canceled.

Alternatively, a door obstacle control is required, (“nudging”) which in response to triggering of the photoelectric cell, after an adjustable delay, shall close the doors at lower speed, while providing an audio warning “door obstacle”.

The extractable safety bar and the “Door Open” button shall remain active. Pressing the “Direct’ button shall cancel the “nudging” control.

4.4 TRACTION MACHINE

The lift machine must be Permanent magnet Gearless type Installed inside the lift shaft (MR). The Machine shall be a heavy bronze casting suitable for the lift.

The drive sheave shall enable dismantling for repairs and shall be designed so as to prolong cable’s life. The drive sheave shall be iron cast having at least 180 GB (Brine’s Hardness), approved by the Engineer. The drive sheave shall comprise a safety device for preventing cable release from the fasteners.

The diameter of the drive sheave shall be at least 40 times the diameter of the rope.

The Traction angle of the ropes over the drive sheave shall be at least 160 degrees

4.5 ELECTRIC MOTOR

A special single speed type motor for lifts, suitable for high initial torque leads. Starting current being 3 timed the nominal current.

Three phase 400 V power, 50 HZ permitted voltage fluctuations +/- 10% Motors are protected by overload circuit breakers comprising automatic cut-off, activated by each phase and each winding, separately. The free shaft of the motor comprises a manual operating handle, indicating the direction for raising and lowering.

The motor shall not overheat, even under heavy-duty operation and a high ambient temperature.

A thermocouple shall be provided at the motor’s coils, for disconnecting the motor, only after a ride, in case of winding overheating.

If necessary, a force-cooling motor shall be supplied

A speed control system is required in lifts for controlling acceleration and deceleration according to a preselected program.

The acceleration and deceleration shall be according to manufacturer standards stopping and braking the lift shall be electric, without using the mechanical brake, which during the regular course of operation, shall be used only after the lift has come to a complete stop. The system shall be a closed loop-type comprising input from a taco-generator mounted on the motor shaft and its performances may not be affected by the lift load. Lift access to a stop shall be direct without creeping speed.

Speed control shall be accomplished by Variable Voltage Variable Frequency System (VVVF) and if starting or braking resistors are required, they shall be mounted outside the motor room. Stopping accuracy +/- 5 mm.

The drive system shall comprise special safety elements for emergency braking, using the mechanical brake, in the following cases:

a. Difference between actual speed and preselected, programmed speed.
b. Traveling in an opposite direction to that planned.
c. No slowing at an external stop.

These safety features shall be independent of the standard control system.

4.6 MACHINE ISOLATION

The entire machine, including all its parts, shall be mounted inside the shaft, isolated by rubber cushions from other parts of the building, preventing vibrations or noise from penetrating the building.

The machine must be leveled after the carload has been balanced.

4.7 GUIDE RAILS

The car and counterweight rails shall be made of special lift profiles, suitable for different car sizes and loads.

The rails shall be extruded or wrought steel and shall include sufficient attachments, including fasteners and other accessories (each rail contains at least two attachments).

Car and counterweight rails shall be connected to the building by bolts.
Lifts prices shall include all rail attachments, separation beams and separation nets within the shafts.

4.8 COUNTERWEIGHT

A rigid profiled steel frame filled with cast iron blocks. Balanced load: 45-50%.

4.9 CAR AND COUNTERWEIGHT GUIDES SHOES

Special sliding guide shoes with suitable coating, adjustable for silent operation.

4.10 DEFLECTION PULLEYS ON CAR-COUNTERWEIGHT FRAMES

Diameter of deflection pulleys shall not be less than 40 times the ropes diameter. The pulleys shall have a strong structure and shall comprise cylinder bearings, with anti-dust protection and appropriate lubricating means.

4.11 CONTROL SYSTEM

The lift shall stop at according to the order of floors and not according to the order of calls. Stopping at a floor cancels the call. Each controller comprises a processor (computer) analyzing hall calls in the building, car calls, lift loads and direction of travel, and then optimizes lift dispatch, so that waiting time and lift travel time will be optimal.
The lift is provided with a weighing system for continuous weighing of the load as and input to the controller serving as criteria for dispatching a lift to an external call. The other lift shall park at a station which according to system calculations shall offer minimum response time to an external call.
The “Out of Service” status shall occur in one or more of the following cases:

A. Power supply to lift interrupted.
B. Lift is in “serviced” control.
C. “Stop” switch was activated on car roof.
D. Non-response to a registered call, by a particular lift, within about 40 seconds.
E. “Direct Control” switch has been activated.
F. Lift safety line was disconnected.

4.12 Full Collective Selective Controls (Up & Down)

Full collective selective control (up and down) – Group: each call shall be registered in the system memory. The lift shall stop according to the order of the stations and not in the order of registration of the calls. The lift shall first respond to calls from one direction and only then does it change direction and respond to calls from the other direction and respond to calls from the other direction. Stopping at a floor cancels only a call registered for the direction the lift is traveling. When the “overload” switch is activated, the lift shall not respond to external calls. These shall remain registered, and response will follow only after cancellation of “overload” status.

4.13 Push-Buttons Control Stations

At each entrance there shall be a push-buttons array for calling and sending the lift. A light flashes during lift travel and is lit when the lift is parked at a station, but in use. The light will not illuminate when the lift is not in use and available. Furthermore, on each floor there shall be a light indicating the presence of a lift on that floor. A buzzer will be operated on arrival of the car.

4.14 CONTROL AND COMMAND FIXTURES:

Command and control fixtures and push-buttons shall be made of a material and shall bear the script as per the Engineer's decision. Designs of Contractor shall be approved by the Engineer before manufacture. All the fixtures shall be mounted in suitable boxes.

4.15 Hall

Every stop has an illuminated call push-button, for registering a call, for downward bound calls (the push-buttons are positioned between each pair of lifts). There are two push-buttons on the main floor.
Each stop has direction arrows (flashing during travel), with a gong above the stop door (the gong will ring only when a lift responds to an external call, about 5 seconds before arrival of the lift).
A fireman control key is installed at main floors for the determined lifts as a fire lift according to code.

4.16 Car Operating Panels

- Registering push-buttons for served and additional floors (illuminated for call registration).
- Floors designation with additional to be B2, B1 GF, 1ST.
- Alarm push-button connected to Charger battery.
- Intercom push-button connected to Charger battery.
- Fan switch.
- Lighting switch.
- Key switch for “direct” (“independent”) car control (responding only to car calls and canceling hall calls). When this command status is activated, and there are no car calls, the lifts park with open doors and do not respond to hall calls.
- Key switch for canceling lift operation (may be installed at main
- Floor).
- “Door Open” push-button for opening the door, operation
- Corresponds to photo electric cell and door force limit.
- Key switch for canceling photo electric cell operation.
- Floor indicator. (Above entrance).
- Direction indication arrows (flashing during travel). (above
- Entrance).
- Over-load buzzer and illuminated signal.
- Fire alarm control key switch.
- “Door Close” push-button: cancels door delay.
- SOUND SYSTEM

The lifts shall park at the floors with doors closed. Pressing an external call push-button, when the lift is at that floor, causes doors to open.

4.17 ACCESSORIES ON CAR ROOF

Service connection box with “Joint Push Button”, Up Push Button”, Down Push Button” “Stop”, transfer switch for service control, portable lamp, socket outlet and alarm bell, powered by the emergency lighting battery, as per standard, emergency exit door contact, slackened cable device.

4.18 CONTROLLER

The controller shall be constructed of a frame, or rigid bent metal sheeting, with shock isolation to prevent damage of instruments mounted on the panel. It shall comprise front and rear metal doors taking into consideration maximal ventilation of the panel.
Entirely solid electronic control panel shall include a microprocessor linked to all the shaft and car entrances (door switches, switches, limit switches, call push-buttons, etc.). Based on available information, and according to software adapted for lift control (may be modified), the microprocessor shall emit control commands to the door contactors and to the main contactors for closing the door and for lift travel, as well as floor indications, direction arrow indicators, etc.
All the input ports of the panel shall have high access impedance and an external short shall not disrupt panel operation.

Input ports form safety circuits shall have galvanized isolation from the control.
The panel shall contain standard printed circuits, for easy extraction and replacement without requiring tools.

Card connector's location shall prevent installation of an incorrect card.

Safety circuits input ports (door switches, locks, limit switches, etc.) shall not be in close proximity to each other in order to prevent random shorting of the safety circuits.
The "Zero" line for the safety circuits shall be grounded so that an electric short in one of the safety line components shall not prevent the lift form traveling and burnout of relevant electric fuse.
At a prominent location on the control panel, LED (light emitting diodes) shall indicate the status of the shaft switches, permitting rapid trouble shooting. The panel shall further contain a digital floor indicator comprising a standard, 7-segment element.
An external socket panel may be offered for connection to an analyzing system for analyzing logical command status, registration of external and car calls, etc. The transformers shall be designed and constructed for continuous high load, with optional first and secondary side adjustment.
The panel's transformers will be located at the bottom of the board and shall be protected against human contact. Ventilation must also be taken into consideration.
Current rectifiers shall be load-bearing, unaffected by sudden momentary power surges and shall be in a ventilated location.
Current rectifiers shall be located as close as possible to their circuit, permitting easy access for servicing and replacing, without the need to dismantle an adjacent device.
The contactors shall be mounted in an isolated corner, to prevent danger to the service man.
An over-load device shall be set to the nominal current of the motor with a start-up delay.
A device preventing lift operation in case of reversed phases, or in the absence of one phase, shall be included in the panel.
The fasteners shall be uniformly marked on the board. Fasteners, or main electric supply screws, power, and lighting, shall be separated and remote form control circuit and signaling fasteners.
Wiring shall be professional, tidy, and aesthetic.

Selector to be electronic, operated by metal plates and an indicator on the car ceiling. Alternatively, floor switches in the shaft, or a selector to be operated by a plate or chain, or by an infra-red contact counting pulses.
All the device including fasteners, or fastening screws, shall have uniformly marked tags, identical to the control diagram. Mechanical assembly plans for the devices on the board, and electric control diagrams shall be provided inside the control cubical.
The control panel shall include call push-buttons for end floors, door-open cancel switch, as well as a service table, including a switch for transfer between "service" and "regular" control.
The "down" push-button shall bypass a top limiter. The "up" push-button shall bypass a bottom limiter and a safety contact device.
The control system shall store data in a microprocessor, permitting data retrieval by means of a system with a screen.
The required data is:

a. Registration of historic faults (the failures shall also remain registered even in the event of power failure to the control panel).
b. Registration of waiting time for calls and traffic analyses.
c. Lift status display shall include a graphic display of the lift location, direction, closing or opening of the door, registration of car and/or external calls, indication of the lift receiving the call.

4.19 ELECTRICAL INSTALLATIION

Piping and conduits must be protected and well supported, to prevent them from coming loose due to vibrations.

Distribution boxes, passages, or piping connections must be individually supported. They must be properly sealed and adapted for rapid opening for servicing or checking.

Connections for the above boxes shall be clamp connectors, marked in the identification diagrams.

Loading of the tube and conduit space shall not exceed 70% of their internal capacity. Piping between safety switches shall not have connections.

Piping connectors to safety switches, locks or any other device, shall be by suitable, fixed tubes, protected from damage.

Equipment requiring adjustment after the piping is fixed, shall be connected by flexible pipes, permitting intermediate and final adjustments.

The entire piping system, floor push-buttons, floor indicators, distribution boxes and safety switches in the shaft, made of metal, must be grounded.

Car piping must be protected and conduits from car frame to car body shall be flexible, preventing the car form being affected by the frame's vibration.

Traveling cable will be special Flat lift cables, with a steel or linen core. Each traveling cable will have 20% spare and at least 3 extra cable wires. The control cable shall be separate from the lighting and indication cables. The piping system shall be watertight to prevent infiltration of water.

Wires in the boxes or at angles shall not be tangled.

Safety circuit breakers such as: "Stop" switch, or other switches, shall be a positive safety switch.

Illumination above the car shall be stable and operable by an accessible, isolated switch. Shaft switches shall be protected.

Car and all metal Parts shall be grounded.

The piping shall be implemented according to the Local Code and the requirements of the Electric Company.

4.20 INTERCOM

Internal communication system for each lift to be connected between cars and the internal communication system of the building and to the top of shaft.

The Contractor shall provide 8 reserve wires in the traveling cable, for the internal communication system, in addition to the reserve wires required in the specification. The Contractor shall also provide another contact in the alarm push-button and suitable

Apertures in the push-button panel for installation of a speaker in the push-button panel, and loudspeaker for music.

The intercom system shall be installed by the supplier (the intercom system shall be powered from a rechargeable battery).

The developer shall connect an additional in the car via those reserve wires.

4.21 SAFETY ARRANGEMETNS

A. Car and Counterweight Safety Device

Suitable for nominal speed and activated by a speed governor in the top of the shaft. A speed governor shall activate the safety device in case downward traveling speed increases by 15-20% (of lift speed).

B. Buffers

Rubber or spring buffers under car and under counterweight in the pit.

C. Safety Edge

For preventing entrapment in case of encountering automatic door during motion. The activating force according to the Code.

D. Safety Contact

In case of activation of the safety device or loosening of suspension cables

E. Speed Governor Contact

Activated by the speed governor for disconnecting safety circuits.
For loosening speed governor rope and/or descent of tensioning weight of speed governor cable.

4.22 FINAL LIMIT SWITCHES

To be activated by car as it passes and stops. A limit switch shall halt power supply of all 3 phases, or, alternatively, the main command power line which disconnects all 3 phases of power to the motor as well as the brakes, at both supply extremities.

4.23 MAIN SWITCH

A 3 phase main circuit breaker for each lift shall be installed at the top of shaft and protective devices against high current, phase shortage, and phase reversing, shall be installed by Contractor, for each lift.
Furthermore, and automatic cut-out relay for lift lighting will be installed by Contractor (in the event that a separating transformer is not installed).

4.24 PAINTING

All metal components shall be coated by two layers of anti-rust paint

4.24.1 PIT Ladders

One Fixed Steel Ladder in each lift pit for easy maintenance and inspection.

4.25 SILENCE OF OPERATION

Precautions shall be taken by the contractor to ensure quietness of operation of the entire lift installation with special regard to the motors, brakes, controllers, reduction gear, terminal floor switches, and solenoid operated ramps, car gate-.lock ramps and gates to ensure that any vibration generated by the lift equipment is not transmitted to the building structure.

4.26 EMERGENCY EVACUATION SYSTEM

Emergency evacuation battery backup system shall be provided by the contractor each lift. They system shall be capable to provide power supply to the lift in case of electrical mains cut off and on other emergency. The battery backup system shall drive the lift to a pre-determined (selected) parking floor and open shaft and car doors, which shall remain open until the emergency case is over.

4.27 SPARE PARTS

Batteries shall be maintenance free sealed lead acid complete with charger, controls, cabinet, wring, installation and connections to lift control panel etc.

The contactor shall guarantee to provide the owner with all spare parts needed (against cost) in the future and for at least 15 years period starting at the end of the free maintenance period.

4.28 Other Features

Firemen’s switch, car telephone set, In-car direction lanterns, hall lanterns, car gong, hall position indicator, load- weighing by-pass, mirror, and other approved manufacturer's standard features.

4.29 Emergency Landing Device (MELD):

Upon power failure, a car automatically moves to the nearest floor using a rechargeable battery to facilitate the safe evacuation of passengers.

4.30 Firefighter Emergency Operation (FE):

When the fire operation switch is activated, the car immediately returns to a predetermined floor. The car then responds only to car calls, which facilitate firefighting and rescue operations.

4.31 Fire Emergency Return (FER)

When a key switch or a building's fire alarm is activated, all cars immediately return to a specified floor and open the doors to facilitate the safe evacuation of passengers.

4.32 Car Lighting

Energy LED Lighting

4.33 Inter communication system & CCTV Provision:

Lift FLAT travelling cables shall contain shielded pairs of conductors for each car for the intercommunication system& CCTV SYSTEM.

4.34 WARRANTY

The Contractor is responsible for all installed parts, materials, facilities, instrumentation, and quality of for period of (24) months all included in price. The warranty period shall start at the beginning of the defects liability period. The warranty is contingent upon the provision of service by the Contractor during the warranty period.

The Contractor shall implement repairs, adjustments, etc. Immediately and at its own expense when summoned by the Client during the warranty period according to the requirements of the Client and upon its approval, within the shortest period possible.

The supplier must maintain a reasonable stock of original spare parts in order to comply with the requirements of the warranty.

The price includes a two -year free maintenance which mentioned above written contract must be assigned with the local agent supplier labor and parts.

The representative of the Client shall implement the second acceptance inspection at the end of the warranty period and the Contractor shall implement all repairs, modifications, replacement of defective, damaged or unsuitable parts according to the results of the abovementioned tests.

An additional inspection shall be implemented after the repairs are completed and additional **warranty** period of (24) months shall apply to those parts replaced during the warranty period, starting from the date the repair was completed.

Approval of the drawings or acceptance of the lift by the Engineer does not relieve the Contractor of its responsibilities according to this clause.

After (3) months of operation and use (which shall be considered as the running-in period), the Contractor undertakes that the number of call backs which shut down the operation of the lifts which are the responsibility of the Contractor shall not exceed 6 call backs per year

The supplier shall warrant the elevator **Motors** & **Ropes** against defects in materials and workmanship and correct any defects not due to ordinary wear or tear or improper use or care which develop within (10) years from the date elevators are accepted by the

END OF SECTION

SECTION-16000
ELECTRICAL WORKS

PART 1 – GENERAL

1.1 INTRODUCTION:

A. The contractor must have, during the entire duration of the Contract, qualified electrical engineer for ensuring proper execution and supervision of work. The electrical engineer should be registered with the Jordan Engineer's Association and his name, qualifications and experience should be submitted for approval. The electrical engineer should be available at site during all working hours.

B. The name of the electrical engineer and details of his experience and his staff qualifications and experience shall be submitted by the Contractor.

1.2 SCOPE OF WORK

A. The Work included in these Specifications is for the complete Electrical Services for the Project. The Work described and included in this Specification is for the manufacture works, testing, supply, delivery to site, erection, connection, site testing, demonstrating, commissioning and maintaining for required duration, all equipment and installation as described in this Specifications and shown on Contract Drawings.

B. All Electrical Works complete in all respects shall be provided in accordance with the requirements of the Contract Documents.

C. The Contractor shall supply, install, test ,commission and maintain all materials (or farther more stated concerning operating, maintaining and cleaning), shall include, but not be limited to the Electrical systems below :

1. LED Lighting System.
2. Power system.
3. Elevators.
4. Emergency diesel generators.
5. Automatic Transfer Switch (ATS).
6. Uninterruptible Power Supply UPS.
7. Earthing system.
8. Lightning protection systems.
9. Fire Detection and alarm System.
10. CCTV System.
11. DATA SYSTEM.
12. IP-Telephony
13. Access Control System.
14. Voice Evacuation (VES).
15. Public address (PA).
16. Automatic door controls.
17. Shatter windows.
18. Gate shatter.
19. Sliding gates motors.
20. Gate barriers system.
21. Electrical Raceway Systems (conduits, trays, ladders, trunks)

The Contractor shall include all parts, materials and services necessary to ensure that the whole of the works is complete and will be handed over in satisfactory working order, so that it will correctly perform for the anticipated lifetime of the work.

1.3 REGULATIONS

A. Authorities and Regulations

The Contractor shall comply with all statutory requirements and regulations issued by the local authorities within whose area of jurisdiction the site is contained.

The Contractor shall also comply with the relevant "Codes of Practice" issued by the British Standards Institution and the latest edition of the "Regulations for the Electrical Equipment of Buildings" issued by the Institution of Electrical Engineers, and any supplements thereto.

1.4 ELECTRICITY SUPPLY

A. All electrical equipment accessories and fittings shall be designed and manufactured to operate continuously in the electricity supply system having the following characteristics:

1. Nominal voltage 400 VAC, 50 Hz, three phase (3P+N+E), Neutral and Earth.
2. 230 VA
3. C, 50Hz, single Phase (P+N+E).
4. Frequency 50 Hz.
5. Neutral Solidly Earthed.
6. Power Transformers Nos.
7. Standby Power Diesel Generator.

1.5 STANDARDS AND REGULATIONS

A. All works contained herein shall be subject in every respect to the approval of the Engineer.

The design manufacture installation and testing of all materials and equipment shall comply with the latest Local Authorities Specifications. Where no particular item is not specified by Local Authorities Specifications, relevant recommendation of the International Electro technical Commission (I.E.C.) and if this is not available then with the latest relevant British Standard Specification (B.S.) or other approved National Standards. Specifically the following standards/ regulations / codes shall be acceptable:

- General Technical Specifications for Buildings, Electrical Installations, Part 3 – Ministry of Public Works and Housing, Jordan.
- Requirements for Electrical Installations for Buildings (IEE Wiring Regulations) published by the Institution of Electrical Engineers, London UK.
- Jordanian Electrical Codes.
- International Electrical Commission (IEC).
- National Electrical Code (NEC).

- IES/CIBSE Illumination codes.
- CIE International Commission on Illumination.
- International Commission for Conformity Certification of Electrical Equipment (CEE).
- Specifications for Installation of Telephones, issued by the Ministry Of Telecommunication.
- The latest relevant recommendations of the committee 'Consultant International Telephone and Telegraph (CCITT).
- Civil Defense Fire Department in Jordan.
- National Fire Protection Association (NFPA).
- Jordanian standards and metrology

B. Standards for materials and the design of equipment are quoted throughout this specification and the Contractor shall produce copies of these Standards as required and instructed by the Engineer. If the Contractor offers equipment, which is not manufactured, in compliance with those Standards the equipment offered should be at least equal in performance and quality to that required by the relevant Standard.

C. In the event of the Contractor offering materials or equipment which differs from that described in this Specification, the Contractor shall include for all the costs involved in checking the design, any necessary redesign, drawings and the modifications to other equipment of the affected system.

D. While making an offer, the Contractor should specify the name of the Manufacturer he intends to use for the supply of each equipment material / light fitting etc. In offering such material or equipment or light fitting he shall include with his tender the detailed information necessary to demonstrate quality. The presentation of such data shall take the form of a comparison sheet giving on one column the critical parameters required by the relevant Standard and/or equipment specified and an adjacent column giving the standards of the equipment offered in the Tender. Where manufacturers names are particularly specified for any item, the contractor must choose from the specified manufacturer(s).

1.6 CAPACITIES AND DERATING FACTORS

The capacities and ratings of the equipment, electrical components and accessories shall be sufficient to give satisfactory service in the environments conditions stated herein before.

Sizes of electrical cables and wires shall be determined by suitably derating the current ratings of such cables and wires in accordance with the rating factors indicated in the I.E.E. Regulations. The attention of the Contractor is drawn to the fact that the application of derating factors for the higher ambient temperatures will not by itself render the equipment suitable for the climatic conditions of the site. Full considerations shall be given to the severe climatic conditions.

1.7 FUSING AND PROTECTION

A. The rating (in amperes) of circuit breakers, switch fuses and circuit ways of distribution boards given on diagrams or drawings are the maximum normal (operating) rating permissible for such circuit.

B. On completion of the installation, it shall be the responsibility of the Contractor to set the overload protection appropriate to the actual loading on each circuit.

C. The Contractor shall be held liable to make good any damage resulting from overloading should it be discovered that overloads where improperly set or fused incorrectly rated.

D. Under no circumstances shall cartridge fuse carriers be bridged with loose fuse wire. In the event of such malpractice being discovered, the Contractor will be required to replace the whole assembly if such a fuse is blown.

1.8 RADIO INTERFERENCE SUPPRESSION

A. All electrical equipment shall be provided with suitable means of suppressing radio frequency interference fully in accordance with various requirements stipulated in relevant British Standards.

1.9 DIMENSIONS OF EQUIPMENT

A. The Contractor shall ensure that all plant and equipment included in his offer can be accommodated in the position shown on the drawings without structural alterations. The Engineer will not consider any claims for additional payments resulting from modifications arising from equipment of unsuitable dimensions being provided.

1.10 DRAWINGS

A. Before signing the contract, the Contractor should obtain a set of the approved drawings by the local authorities. It shall deemed to be understood that Contractor has taken into account the difference between Tender Document / Drawings and the approved drawings and that he shall not be eligible for any additional payments / variations etc.

B. Refer to all other Architectural, Structural and Mechanical Drawings to verify all spaces and conditions affecting the electrical work and to ascertain the location and routes of all gas and water services, AC ducts, piping ...etc. to maintain adequate clearance between electrical and other services. The Drawings shall be available at the main contractor's Office. In case of discrepancy, the decision of the Engineer shall be final.

C. Shop Drawings

1. Prepare and submit for approval, before commencing any portion of the Contract work, complete shop drawings, which shall show:
   - Exact routes of cables and ducts including sizes and details of installation.
   - Cable trays and ladders giving routes, sizes and details of supports and hangers. Exact runs of conduits and trunking including sizes, draw boxes and junction boxes and the number and sizes of wires in each run.
   - Switch boards and distribution boards and control panels including location, layout, dimensions, fixing details, cabling and final connection arrangement.
   - Proposed supports and hangers for cable trays, trunking, conduits, cables, and light fittings ...etc. including details of materials, finish, sizes and method of fixing to structure.

- The contractor shall submit sections and elevations as required by the Engineer to show details of installation showing plant, equipment, fixtures in true dimensions in relation to furniture and other elements in the concerned area.

2. Shop drawings shall be made to a scale not less than 1/100 or as required by the Engineer. Shop drawings for the electrical rooms, generators rooms, transformers rooms, UPS rooms shall be made to a scale not less than 1/50 or as required by the engineer. A detailed duly updated record shall be kept by the Contractor of all service distribution routes and installation work during the Contract duly titled.
3. The shop drawings shall be coordinated with the work of all other trades and shall where necessary show adjacent services to indicate satisfactory coordination. Where necessary or when requested by the Engineer, provide coordinated sections to a suitable scale to suit each condition. Drawings of other Trades which are not forming part of this Contract if required for coordination purposes will be issued to the Contractor by the Engineer.
4. Engineering data covering all equipment and fabricated material to be supplied shall include drawings and descriptive information in sufficient detail to show the kind, size, arrangement and operation of component materials and devices.
5. All deviations from the contract documents shall be identified on each submittal and shall be tabulated in the Contractor's letter of transmittal. Such submittals shall, as pertinent to the deviation, indicate essential details of all changes proposed by the Contractor (including modifications to other facilities that may be a result of the deviation) and all required piping and wiring diagrams.
6. The Contractor shall accept full responsibility for the completeness of each submission, and, in the case of a resubmission, shall verify that all exceptions previously noted by the Engineer have been taken into account.
7. The Engineer's review of drawings and data submitted by the Contractor will cover only general conformity to the drawings and specifications. The Engineer's review does not indicate a thorough review of all dimensions, quantities and details of the material, equipment, device or item shown. The Engineer's review of submittals shall not relieve the Contractor from responsibility for errors, omissions, or deviations, nor responsibility for compliance with the contract documents.
8. When the drawings and data are returned marked "NOT APPROVED" or "APPROVED AS NOTED", the corrections shall be made as noted thereon and as instructed by the Engineer and one corrected copy and one corrected reproducible copy shall be resubmitted. Fabrication shall not commence until the final drawings have been returned marked "APPROVED" by the Engineer. When corrected copies are resubmitted, the Contractor shall in writing direct specific attention to all revisions and shall list separately any revision made other than those called for by the Engineer on previous submissions.

D. Progress Drawings

1. Furnish and keep on the job site at all times, one complete and separate set of backline prints of the Electrical Work on which shall be clearly, neatly and accurately noted, promptly as the work progress, all electrical changes, revisions and additions to work as actually installed. Wherever work is installed other than as shown on the drawings, such changes shall be noted.
2. Indicate daily progress on progress prints by coloring in the various parts of the Works as they are erected.

E. As Built Drawings

1. At the conclusion of work, prepare and submit “As Built Drawings".

2. These drawings shall be titled "As Built Drawings" and shall be prepared from the marked up progress prints.

3. Submit "As Built Drawings" to the Engineer for review and approval.

4. Should there be any difference between the final "As Built Drawings" and the Contract Drawings then arrange for obtaining approval of the final "As Built Drawings” from the local authorities.

5. The Contractor shall submit "As Built Drawings” as under:
   a) 3 sets of computer compact disk (CD) prepared on AutoCAD.
   b) 5 sets of paper prints of the "As Built Drawings" each set in binder form.

F. Approval from Authorities

The contractor shall be responsible for obtaining design and as built approvals from all local authorities, Civil Defense Fire department, etc. in respect of the following:

1. All works executed by him including any extension works added during construction.
2. Any changes made on the design during construction.
3. Any alterations, modifications made during construction.
4. Any other approvals specifically asked for in this document or B.O.Q.

1.11 DISCREPANCIES

A. The Contractor shall be responsible for any discrepancies, errors or omissions in the electrical drawings and information supplied by him whether they have been approved or not, provided that such discrepancies, errors or omissions are not due to inaccurate drawing or information given to the Contractor by the Client or the Engineer.

PART 2 – PRODUCT

2.1 MATERIALS

A. All equipment and materials used in the electrical installation work shall be new and of the highest quality AND STANDARDS. They shall be suitable for operation the standard voltage and frequency in Jordan.

B. Unless otherwise specified, all equipment and materials shall comply as a minimum with the latest relevant recommendations of the International Electro technical Commission (IEC). If these are not available for any equipment or material then the latest relevant British Standard shall be followed.

C. If standards mentioned above contradict with this Specification, then the requirements of this Specification shall prevail.

D. Electrical equipment and material complying with other national standards may be considered for use in the work provided the Contractor shall, at the time of submitting his offer, confirm in writing that such standards meet the requirements of IEC / BSS as regards characteristics, requirements and testing procedures as a minimum. The Contractor, if awarded the work on the basis, shall be required to substantiate this by producing all relevant data and test certificates and, if needed, by report from an approved inspecting and testing authority confirming that the results of the tests carried out on these equipment and materials meet the requirements of IEC / BSS as a minimum. Only after the production of such evidence and subsequent approval of the Engineer should the equipment and materials be delivered to site.

E. Submit to the Engineer full details and particulars of all equipment and materials proposed for use and no material shall be ordered, delivered or constructed without a written approval from the Engineer. Any material or equipment, which is not approved but installed, shall be removed and reinstalled with approved one at the Contractor's expense.

F. The details of equipment and materials submittals shall include the following:
   1. Full technical specifications of equipment including construction, materials, degree of protection, characteristics, curves, diagrams, ratings, dimensions, fixing details, etc.
   2. Relevant **confirmed sheets** of manufacturer's catalogues, specifications, technical data ...etc.
   3. **Confirmation** that equipment and materials offered complies fully with relevant Clauses of the Specification and, in case of deviation from the Specification, a schedule of deviations listing all points not conforming with the Specification. All these details shall be submitted clearly in Compliance Sheets for each materials.
   4. Short circuit study including all components shown on the Schematic Diagrams.

G. Submit, at the request of the Engineer, a sample of any equipment or material for further study before approval.

H. Products specified by property name are to comply with the Specification requirements.

I. No order shall be placed by the Contractor for major material or equipment unless written approval of the Engineer has been obtained. The Contractor shall report monthly progress of the purchase orders to the Engineer submitting to him a copy of the orders.

J. The contactor THROGH THE SUPPLIER must provide the owner with a full detailed technical specification shown in the purchase order (PO) documents FROM THE MANUFACTURER FACTORY.

K. The Contractor is not permitted to change the original tender documents. If he wishes to suggest the use of items, which are different from the description in the tender documents, these must be submitted as separate alternative offers.

L. Alternative offers will be evaluated only if all requirements of the tendered system are fulfilled, regarding the technical requirements, reliability and safety, compliance with the regulations, availability, space requirements, costs and energy requirements.

M. Alternative offers will be considered only if the specified products and performances are exactly described with detailed documentation, sufficient to allow the Engineer to verify beyond doubt that the above requirements are fulfilled.

N. Only new equipment of highest quality will be acceptable. The Contractor is to inform the Engineer in writing, if he knows that a change in the offered or ordered goods due to a change in production, standards or regulations is to be expected. If there are any doubts about the equipment mentioned in the tender documents, the Contractor must notify the Engineer in writing together with the submission of his offer.

If required by the Engineer, samples of the equipment are to be presented to and approved by the Engineer before it is offered by the Contractor. The Contractor shall on demand supply the certificates of origin for materials.

If certain brands are particularly stipulated in the specifications, they must be offered. However, the Contractor may alternatively suggest and quote other brands of equal quality in a separate document together with his OFFER.

PART 3 – EXECUTION

3.1 WORKMANSHIP

A. The works shall be executed in a neat, substantial and workmanlike manner. All workmanship shall be strictly first class in every respect and shall be performed only by skilled workmen.

B. Whether or not shown on the Drawings, equipment shall be installed in such a manner that equipment, operating and control devices ...etc. are readily accessible for service and adequate access spaces are maintained.

C. Obtain detailed information from the manufacturers of equipment as to proper method of installation and connection of this equipment.

D. Should any portion of the Contract works which should reasonably and obviously be inferred as necessary for the complete, safe and satisfactory operation of the electrical installation as a whole, but not expressly described or specified, provide and execute such works as part of the Contract.

3.2 IDENTIFICATION AND LABELLING

A. The components of all main and sub-main switchboards, all distribution boards, switches, isolators and other items of plant shall be clearly identified by means of labels secured to the external surfaces of the units designating the function of these units.

B. The labels shall be 2mm. "Trifoliate" of minimum size 50 x 20mm with 5mm black lettering on white background fixed securely to front plates of distribution boards, switches, circuit breakers, isolators, starters, push buttons, lamps instruments ...etc.

C. In addition to this, each distribution board shall also be provided with circuit schedules fixed rigidly inside the door of the board and indicating the number, rating, type of load and location of each circuit in the board.

D. Each end of each cable shall be provided with identification labels lettered with feeder or circuit designation to the Engineer's instructions. The labels shall be permanently fixed in distribution boards, terminal boxes, isolators, etc.

E. Manufacturers name plates shall include manufacturer's name, model or type number, serial number and all applicable ratings clearly marked thereon. The name plates shall be placed in a conspicuous location on the equipment.

3.3 TESTING AND COMMISSIONING

A. On completion of the entire electrical installation work or any separate or distinct part thereof, notify the Engineer, in writing, that the completed part of the electrical work is ready for inspection. Before doing so, perform initial trial tests. Test, correct, adjust, balance, regulate, etc. the section concerned as necessary until required conditions are obtained.

B. The inspection of the Contract work shall be carried out in the presence of the Engineer and shall comprise of but not be limited to:

1) Verification of polarity.
2) Effectiveness of earthing.
3) Insulation resistance test.
4) Test of ring circuit continuity.
5) Phase rotation.
6) Operation tests of relays, interlocks and any other protective and control device to ensure correct functioning.

The results and readings obtained shall be recorded on forms.

C. Supply all instruments and tools required for carrying out the tests.

D. In case that the above mentioned tests are satisfactory and no errors or faults appeared in the installation, submit the necessary test forms duly filled, to the local authorities and to repeat, if necessary, the tests in the presence of the local authorities Inspector.

E. Follow-up and make all necessary arrangements with the local authorities for the purpose of providing permanent electricity supply and telephone service. Also provide all facilities and attendance to the local authorities for any other tests carried out before energizing the installation.

F. After the connection of the supply to the installation, commission all parts of the electrical installation covered by this Specification and demonstrate to the Engineer that the entire electrical installations are in perfect working order.

G. When equipment or services of a specialized nature are involved, and if it was found necessary, provide the services of a specialist from the manufacturer who shall be present at the time of testing and commissioning of this equipment. Include for all expenses incurred in this respect as no claim for additional payment will be entertained.

H. Acceptance certificate will not be issued until all testing and commissioning has been carried out to the satisfaction of the Engineer and local authorities. After local authorities' final approval, electronic copy of as-built drawing shall be given to the Engineer for permanent record.

I. Following successful site testing of all items of equipment, the Contractor will be responsible for the commissioning of the equipment within the plant.

J. The commissioning period shall consist of a start-up period and a running period. During the start-up period individual units shall be put into service and any initial operating faults rectified. The start-up period will end when all items of the plant are operating satisfactorily, at which point the running period will commence. The running period shall be a period of not less than 10 days satisfactory fault-free running of the plant at the conclusion of which the Contractor shall give to the Engineer seven days' notice that he is ready to carry out the final test of the above works.

K. The Contractor shall, as the final test of the whole works, demonstrate in the presence of the Engineer that all electrical equipment systems are functioning as an integrated whole according to the requirements of the specification and are capable of being operated satisfactorily.

L. The final test will be in a form to be agreed between the Engineer and the Contractor but it is envisaged that it will take the form of a systematic check on the functioning of each individual operation that the plant is capable of performing, by all items of the plant, separately and in conjunction with one another.

3.4 OPERATION AND MAINTENANCE MANUALS

A. Submit to the Engineer, at the same time of submitting "Record Drawings", properly printed and bound copies of service manuals for the electrical installations to describe the various systems in the fullest details that permit application of proper maintenance, replacement of parts and awareness of system characteristics. These shall include the following:

1. Manufacturer's technical catalogues, dimensional drawings and wiring diagrams for each and every type of equipment installed.
2. Operating instructions for various equipment and systems included in the installation work.
3. Maintenance manuals for all equipment and systems included in the installation work, which need regular and specialized maintenance.
4. Spare parts list with part numbers of various components of all equipment used in the installation work.

3.5 OPERATION AND MAINTENANCE DURING THE MAINTENANCE PERIOD

A. Include for Operation and Maintenance including Preventive Maintenance during the Maintenance Period.

B. Include all spare parts for replacements made necessary due to wear and tear of equipment, consumable parts, short life parts, oils, etc. and all maintenance tools and equipment required for proper operation and maintenance of the Works, the contractor should submit a list of spare parts to be included with his offer for each item.
C. Include for sufficient personnel's to be on call for 24 hours 7 days a week
D. Include all routine and preventive scheduled maintenance as recommended by the equipment manufacturers to keep equipment in perfect operating condition.
E. Keep all records, logbooks, log sheets, maintenance job cards ...etc. in neat order to the satisfaction of the Engineer. All records, log books, and log sheets, charts, maintenance job cards, etc. shall become the property of the Employer.
F. Provide all necessary maintenance and operation staff experienced in both electrical and mechanical work such as engineers, foremen, operators, electricians, mechanics, helpers....etc. for effective maintenance and operation of all systems. Submit to the Engineer for approval qualification details of all maintenance and operation staff.
G. During the Maintenance Period operate, control, maintain, replace and repair any part of plant or material within the Electrical Works Systems which may prove defective due to Contractor's design, erection, operation, performance, or workmanship, or prove defective from any act or omission that may develop from use in the Works or any section thereof.
H. Be responsible for training the Employer's personnel in the correct operation, control and maintenance of the Electrical Works Systems.
I. Training shall be carried out by qualified commissioning and operating staff of the Contractor.
J. The foregoing Clauses are in addition to and in no way relieve the Contractor of his liabilities and obligations under the Contract.

3.6 GUARANTEE

A. Manufacturers shall provide their standard guarantees for products furnished under this Contract. However, such guarantees shall be in addition to and not in lieu of all other liabilities which manufacturers and the Contractor may have by law or by other provisions of the Contract Documents.
B. All materials, items of equipment and workmanship furnished under this Contract shall carry standard warranty against all defects in materials and workmanship. Any fault due to defective or improper material, equipment, workmanship or Contractor's design which develop shall be made good, forthwith, by and at the expense of the Contractor, including all other damage done to areas, materials and other systems resulting from this failure.
C. Guarantee that all elements of the systems are of sufficient capacity to meet the specified performance requirements as set forth herein or as indicated.

D. All warranties / guarantees to be issued by Contractor and will be liable for repair / replace the items / works, etc., during the warrantee / guarantee, period of two (2) years after defects liability period.
A. Spare parts during maintenance period:
Contractor shall provide all spare parts required during the maintenance period at NO cost.
B. In special cases, the spares have been listed in the sections. In all other cases manufacturer's recommended spares shall be provided.

END OF SECTION

Section-16010
General Provisions for Electrical Work

PART 1- GENERAL

1.1 QUALITY ASSURANCE

A. General Provisions contained in this section shall apply and form a part of each and every section of specification, Electrical BOQ.

B. The Contractor shall verify that the materials, appliances, equipment or devices he furnishes and installs under this Contract, meet the requirements of the specified codes, standards AND certifications.

C. The label of, or listing by an independent institute will be accepted as conforming to this requirement. In lieu of the label or listing.

D. The Contractor shall submit independent proof for review by the Supervising Engineer that the materials, appliances or devices conform to established standards, including methods of test, of the country of origin.

E. In addition to the requirements shown or specified in the Contract Documents, all equipment shall be manufactured, tested and installed in accordance with the latest editions of the following standards as listed:

1. **IEC International Electro Technical Commission.**
2. **BS British Standards.**
3. **ISO International Standards Organization.**
4. **VDE Association of German Electrical Engineers.**
5. **IES Illuminating Engineering Society.**
6. **Regulations and instructions of Civil Defense Department.**
7. **UL Listed certifications.**
8. **CE STANDARDS:EN**

F. Codes and Standards listed in the specification sections are intended to provide an acceptable level of quality for materials and products. The Contractor may propose alternative codes and standards provided they are of equal or better quality than the reference codes and standards and are submitted for review and approval by the Supervising Engineer.

G. All items of labor and material required complying with such standards and codes in accordance with the requirements of the Contract Documents shall be included. Where quantities, sizes or other requirements indicated on the drawings or herein specified are in excess of the requirements of the standards and codes, the specifications and /or drawings shall govern.

H. The electrical drawings shall serve to indicate the general layout of the various items of equipment. However, layout of equipment, accessories, specialties and wire ways are diagrammatic unless specifically shown and / or dimensioned.

I. The motor and apparatus wattage ratings shown on drawings are estimated values. The corresponding sizes of feeders and other electrical equipment indicated to serve them shall be confirmed by the Contractor. Motors and apparatus with larger wattage ratings may be furnished if

necessary to meet the requirements of the various sections of the specification in which they are specified. Where larger motors or apparatus with larger wattage ratings are furnished, the feeders and other electrical equipment serving them shall be suitably increased. The increase in the capacity of the feeder and equipment shall be furnished at no additional cost to the Client.

1.2 SUBMITTALS

A. Shop Drawings: The Contractor shall submit for review by the Supervising Engineer, detailed dimensioned shop drawings as stipulated in other sections of Specification, these drawings shall be prepared by the Contractor, shall base on manufacturers installation instructions and shall not be reproductions or tracings of the design drawings. In preparing shop drawings, lines and levels for the work specified shall be established and the drawings shall be checked thoroughly to avoid interference with structural features and the work of other trades. Shop drawings and /or data sheets shall be based on information stated in the specifications and as shown on the drawings and shall show all pertinent information and data for the fabrication and complete installation.

B. Manufacturer's Literature: Manufacturer's data sheets shall be submitted indicating the necessary installation dimensions, weights, materials, and performance information. The performance shall include complete electrical data, including power conditions and identifying types and numbers. Where pertinent, electrical diagrams shall be provided. The above information may be provided by standard sales catalogue sheets marked to indicate the specific equipment provided.

C. Operations and Maintenance Instructions: The Contractor shall furnish data covering model, type and serial numbers, capacities, maintenance and operation of each major item of equipment or apparatus in accordance with the requirements of the Contract Documents. Operating instructions shall cover all phases of control.

D. Spare Parts: The Contractor provide as part of this contract sufficient spare parts required for maintenance of two years of operation after handing over, together with spare parts lists in accordance with manufacturers' recommendations and as directed by the project supervisor.

1.1 PRODUCT HANDLING

A. The Contractor shall be responsible for keeping stocks of material and equipment stored on the premises in a neat and orderly manner.
B. The exposed surfaces of wire ways, conduit systems or equipment which have become covered with dirt, plaster or other material during handling and construction shall be thoroughly cleaned by the Contractor, before such surfaces are prepared for final finish, painting, or enclosed within the building structure.
C. The Contractor shall clean and maintain the work in accordance with the Contract stipulations.

1.3 PROTECTION

A. The Contractor shall keep all raceways and conduit system openings closed by means of plugs or caps to prevent the entrance of foreign matter and cover all fixtures, equipment and apparatus as required to protect them against dirt, water, chemical or mechanical damage both before and after installation.
B. Plugs and caps shall be of such types as to prevent transmission of flood water through any duct, conduit or raceway. Any fixtures, equipment or apparatus damaged prior to final acceptance of the work shall be restored to its original condition or replaced by the Contractor. At completion, fixtures and equipment shall be thoroughly cleaned.
C. The Contractor shall be held responsible for all damage done until his work is fully and finally accepted.

1.4 COORDINATION

A. The Contractor shall be held responsible for the proper coordination of all phases of the work under this Contract.
B. It shall be the responsibility of the Contractor to coordinate the work and equipment as specified herein with work to be performed and equipment to be furnished, under other sections of the specifications in order to assure a complete and satisfactory installation.

1.5 QUALITY OF EQUIPMENT

Quality shall be of the best grade for each type or class, even though such quality may not be stated specifically in the specifications. All materials and products shall be new and manufactured by well-known firms and shall be sound and uniform in quality, size, shape, color and texture and shall be free from cracks, warp age, or their defects. Energy consuming equipment shall be of the energy saving type, wherever relevant and applicable.

1.6 TEMPORARY POWER

A. The Contractor shall furnish and install all temporary electrical facilities, including lamps, required for construction and safety operation. All such equipment shall remain the property of the Contractor and shall be removed when permanent connections have been completed. Where it is determined, during construction, that the temporary facilities, as installed, interfere with other construction operations, the Contractor shall relocate said facilities in an approved manner. No wire, bus or electrical equipment which is part of any of the permanent electrical systems may be used for temporary electrical service for construction operations.

B. Temporary connections shall be safe in accordance with accepted practices. The Contractor shall be responsible for any damage or injury to equipment, materials or personnel caused by improperly protected temporary installations. All costs for materials and installation for temporary electrical facilities and energy for their operation shall be at the expense of the Contractor.

C. Electrical welders used in the erection and fabrication of the building and its equipment shall be provided with an independent grounding cable connected directly to the structure on which the weld is being made rather than to adjacent conduit, piping, etc.

1.7 MANUFACTURER'S NAMEPLATES

Each major component of the equipment wherever possible shall have the manufacturer's name, address, model number and rating on a plate securely affixed in a conspicuous place. The nameplate of the distributing agent will not be acceptable. Code Ratings or other data which are die-stamped into the surface of the equipment shall be stamped in an easily visible location.

1.8 METERING

Metering shall be provided for at the locations indicated on the Drawings.

1.2 SITE SERVICE CONDITIONS

All equipment located in air out-of doors shall be capable of operating continuously under the prevailing conditions regarding dusty atmosphere, altitude and prevailing ambient temperatures (dry bulb).

PART 2-PRODUCTS

1.1 GENERAL

A. All goods and products covered by these specifications shall be procured from the list of approved manufacturers. Procurement of all goods and products manufactured out-of this list must be approved by the owner Engineer.

PART 3- EXECUTION

3.1 WORKMANSHIP

Materials, products and equipment furnished by the Contractor, shall be installed and all work shall be performed in a first-class workman like manner, in conformity with the best trade practices and the printed directions of the applicable manufacturers; by skilled workers equipped to produce satisfactory results; in a safe, substantial manner so as to avoid undue stresses, rigid enough to prevent undue movement, so as not to interfere with work of other trades and so as to preset a neat, orderly appearance and to facilitate operating, servicing, maintaining and repairing.

3.2 FOUNDATIONS AND SUPPORTS

A. The Contractor shall provide concrete pedestals, bases pads, curbs, anchor blocks, anchor bolts, slab inserts, hangers, channels, cradles, saddles, etc.., for installation of equipment and apparatus shown on the drawings and specified in the various sections of specification Division 16, electrical.
B. Concrete pads shall be 200mm high, unless otherwise indicated, complete with steel reinforcing and necessary bolts, anchors, etc. Where concrete pad is set directly on concrete floor, dowels in floor to tie base to floor shall be provided. These pads shall be extended at least 200mm beyond the equipment outline on all four sides.
C. Individual hangers, trapeze hangers and riser clamps shall be provided for supporting conduit and all parts and hardware shall be zinc-coated (galvanized).
D. Pipe straps and hanger rods shall be fastened to concrete by means of inserts or expansion bolts, to brickwork by means of expansion bolts and to hollow masonry by means of toggle bolts. Wooden plugs and shields shall not be used for fastening pipe strips and hangers.
E. Under no circumstances shall duct work, piping and mechanical equipment be used for supporting electrical facilities.

3.3 SLEEVES, CHASES AND OPENINGS

A. Pipe sleeves for all electrical conduit passing through walls, partitions, ceiling, floors, etc.., shall be of sufficient length to extend through the full thickness of the construction, with ends flush with the finish on each side, unless noted otherwise.
B. Contractor shall provide necessary chases and openings in the walls, partitions and floors to accommodate his work.
C. Chases, sleeves and openings in fire rated walls and floors (telephone, electrical closets, etc.) shall be packed with acceptable mineral wool insulation or approved flexible barriers designed for the purpose shall be used. Only UL or similar listed and certified material shall be installed. The fire rating shall not be less than the related wall.
D. Whenever any of the work of the electrical system has to pierce any water proofing, this work shall be done with care and after the part of the system has been put in place through this waterproofing, the opening made by same shall be waterproofed and made absolutely watertight.

3.4 CUTTING AND PATCHING

A. The Contractor shall provide chases, holes and openings for the installation purposes and carefully fit around, repair, patch and otherwise make his work acceptable.
B. He shall furnish and install all sleeves and inserts required for this work. Cutting and patching of any part of the structure shall be done only after review by the Supervising Engineer.

3.5 ACCESS PANELS

Access panels shall be installed where indicated and as required for access to equipment and apparatus. Where, in the opinion of the Contractor access panels are required, but are not shown on the drawings, the Contractor shall provide same and relocate same on the as-built drawings.

3.6 PAINTING

A. All shop fabricated and factory built equipment not galvanized, plated or provided with standard finish paint, shall be cleaned and given one shop coat of lead free primer paint, before delivery to the sit. Under no circumstances, shall the nameplate, label or tag of any equipment be covered with field painting.
B. The exterior of electrical panels, panel boards, cabinets, switchgear, transformers and the like shall be finished in ANSI 61 gray. The interiors shall be finished in a light or white color.

3.7 TOUCHING UP

A. Painting: Damaged or inadequate paint films of shop painted miscellaneous metal materials, and all accessible surfaces of field welds and connection bolts shall be cleaned and prime painted. Touch up paint for shop primed materials and un galvanized bolts shall be the same as that used for the shop coat.
B. Galvanizing: Galvanizing surface scratched or otherwise damaged during delivery, unloading, or erection shall be thoroughly cleaned by wire brushing the damaged area to remove all loose, cracked or bruised galvanizing. Cleaned areas shall then be painted with zinc rich galvanizing paint of an inorganic zinc compound of zinc dust and zinc oxide, with the zinc dust content of 75 per cent or better by weight of the total nonvolatile content. Application of touch up galvanizing shall be applied at a dry film thickness of at least 0.75mm.

3.8 TESTS

A. Prior to starting the electrical installation, the Contractor shall verify the correct voltage, phases and current consumption of all utilization equipment to be voltage, phases and current consumption of all utilization equipment to be connected. Branch circuit wiring, voltage and circuit breakers must be adequate in each case.
B. The contractor shall provide any materials, equipment and labor required and make such tests as specified in the various sections of MECHANICAL EQUIPMENTS and as deemed necessary to show proper execution of the work.
C. Any defects or deficiencies discovered as a result of such tests shall be corrected without additional cost.
D. After the installation is complete and properly adjusted, the Contractor shall conduct operating tests. The various equipment and systems shall be demonstrated to operate in accordance with the requirements of the Contract Document. The Contractor shall provide electric power, instruments and personnel necessary for performing the various tests.

3.9 EQUIPMENT CONNECTIONS AND MOTOR STARTERS

A. In addition to electrical work, the Contractor shall make all electrical connections to mechanical equipment furnished under other sections i.e. the Plumbing, Heating, Air Conditioning and Ventilation.
B. Unless otherwise specified, the Contractor shall mount and align all starters, control devices, safety switches and other related electrical equipment whether specified in this or other sections of the specification, except where such items are factory mounted to the driven equipment. The mounting and alignment of motors, starters, control equipment etc.., for which the feeders are terminated in safety switches as hereinafter specified, are included in the sections of Mechanical Sections, in which the motors etc.., are specified.
C. Unless otherwise specified, the Contractor shall furnish all wiring, including conduit, wire, junction boxes, disconnecting switches, over current protection, etc.., not specified elsewhere in this specification, to and between all motors, starters, control devices and related electrical equipment whether specified in this or other sections of the specification, except where such items are factory wired as well as factory mounted on the driven equipment. All wiring from the above termination points to and between motors, starters and control equipment associated with the equipment named, is included.
D. Wiring for temperature control equipment is specified under this division.
E. Unless otherwise specified, all wiring to motors, control equipment and related electrical equipment, shall be run in rigid metallic conduit with flexible connections where required. Conduits shall be large enough to accommodate motor feeders, grounding conductors and control wires, whether or not so indicated on the Contract Drawings. Wire sizes shall be as shown and as required by the IEC Codes.

3.10 EQUIPMENT ERECTION

A. General: All electrical equipment shall be erected or installed in accordance with the maufacturer4s' recommendations, good electrical engineering practice, and the relevant drawings and specifications.
B. Location Tolerances: Equipment shall be located within 3mm of the dimensional location on the Contract Drawings, unless otherwise permitted by the Supervision Engineer.
C. Lubrication: The Contractor shall furnish a lubrication system schedule and all oils, greases, and other lubricants in accordance with the manufacturer's recommendations, to the Supervising Engineer's approval.
D. Insulating Oil: the Contractor shall furnish all insulating oil required for oil insulated equipment. As soon as possible after receipt of the oil, the Contractor shall sample the oil in accordance with the code for dielectric acceptance.

3.11 BOLTED ELECTRICAL CONNECTIONS

A. General:

1) Where bolted connections are made to aluminum surfaces, the aluminum surface shall be thoroughly cleaned with a wire brush, then coated with joint compound and thoroughly brushed again through the compound. Additional compound shall then be added and the joint together.
2) Where bolted connections are made between copper or brass surfaces, the metal surfaces shall be thoroughly cleaned and coated with a corrosion thoroughly inhibiting compound.
3) The tightness of each bolt in each factory made bolted electrical connection shall be checked during erection and connection of the equipment.
4) It shall be the Contractor's responsibility to certify that the tightness of each bolt in all bolted electrical connections, factory or field, is in accordance with the manufacturer's recommendations.
5) Bolted electrical connections shall be tightened with manual torque wenches. Torque wenches shall be so constructed that they will visually or audibly indicate when the proper torque is reached. The accuracy of each torque wrench shall be checked by a testing laboratory acceptable to the Supervising Engineer immediately prior to its use on equipment erected under these specifications.

B. Connection Bolt Tightness Check:

1) The tightened bolts in electrical connections shall be checked at random as selected by and in the presence of the Supervising Engineer. The Contractor shall provide calibrated hand torque wrenches and the necessary platforms equipment, and personnel for the random check.
2) The number of bolts checked shall be acceptable tot eh Supervising Engineer based upon their observance of the quality and completeness of the tightening operations. A minimum of 10 per cent of the bolts in each connection, but not less than two bolts in each connection, shall be checked.
3) The Contractor shall be responsible for coordinating the checking of bolt tightness so that minimum interference with equipment erection and connection will be experienced. Removal of covers and similar dismantling of equipment to permit the Supervising Engineer to witness the testing of bolt tightness of enclosed connections shall be part of the work included under these specifications.
4) Checking of tightness of electrical connections in the presence of the Supervising Engineer is intended to assist the Contractor in avoiding the expense of repairing costly connection failures. This check shall not relieve the Contractor of complete responsibility for the integrity of the electrical connections.

3.12 SHORT CIRCUIT AND PROTECTIVE DEVICE COORDINATION STUDIES

A. It is the responsibility of the Contractor to check the information given in the Project Documents about voltages and frequency with the Electric Power Company and confirm the data in writing to the Supervising Engineer.
B. Conductors and equipment shall be protected against over current in accordance with their rated ampacities. An over current device shall be connected at the point where the conductor or equipment to be protected receives its supply.
C. Provide four (4) brochures, each of which shall include complete short circuit and protective coordination studies, complete with device coordination time-current curves for the entire power distribution system.
D. In the short circuit study, provide calculation methods and assumptions, the base per unit quantities selected, one-line diagrams, source impedance data including power company system characteristics, impedance diagrams, typical calculations, tabulations of calculation quantities and results, conclusions, and recommendations. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed 3-phase bolted fault at each medium voltage switchgear line-up, unit substation medium voltage terminals, low voltage switchgear line-up, switchboard, motor control center, distribution panel board, pertinent branch circuit panel board, and other significant locations throughout the system. Provide a ground fault study for each medium voltage system, including the associated zero sequence impedance diagram. Include in tabulations fault impedance, X to R ratios, asymmetry factors, motor contribution, short circuit KVA, and symmetrical and asymmetrical fault currents.
E. In the protective device coordination study, provide time-current curves on the Log-Log sheets indicating the coordination proposed for the system, centered on conventional full-size log-log forms. Include with each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered by that particular curve sheet. Include a detailed description of each protective identifying its type, function, manufacturer, and time-current characteristic. Tabulate recommended device tap, time dial, pick-up, instantaneous, and time delay settings.
F. Include on the curve sheets power company relay and fuse characteristics, medium voltage equipment relay and fuse characteristics, low voltage equipment circuit breaker trip device and fuse characteristics, pertinent transformer characteristics, pertinent motor and generator characteristics, and characteristics of other system load protective devices. Include tolerance and damage bands in plotted fuse characteristics.
G. In each brochure, include complete sets of individual protective device time-current characteristics on transparencies.
H. The short circuit and protective device studies may be prepared with a network analyzer, digital computer or by written computations, but must include complete fault calculations as specified herein for each proposed and ultimate source combination.

3.13 EQUIPMENT TESTING AND COMMISSIONING

A. General: The testing of all electrical equipment shall include, but not be limited to, the items below. This shall be in addition to testing specified elsewhere in this specification:

1. General Equipment check.
2. Field wiring and ground system verification.
3. Conductor insulation tests.
4. Equipment adjustment.

The Contractor shall be responsible to make arrangements for power required for testing and commissioning purpose. The testing shall be a continuous process to maintain the construction schedule to the satisfaction of the Supervising Engineer. The Supervising Engineer shall have full access to observe all facets of the testing. All terminals, connections and attachments, all covers, insulating fittings, supports, hardware and field mounted accessories shall be checked for proper tightness.

B. Cable: Testing of all cable furnished and installed under this specification shall be in accordance with all related sections.
C. Grounding: Testing and grounding of equipment and cable, shall include, but not be limited to the tests below:

1. Earth continuity tests shall be made from each item of equipment to the appropriate main ground system and on the main ground system to the ground rods.
2. The resistance to ground for selected ground rods:

All ground resistance measurements shall be made with a three terminal “megger” type ground tester which applies alternating current to the electrodes and which gives a reading in direct current ohms. Two reference ground probes shall be used and all tests shall be made in accordance with the instrument manufacturer’s instructions for ground resistance testing. Prior to connection of ground rods to the grounding system the Contractor shall obtain individual measured ground resistance data from selected ground rods as indicated on the drawings. These data shall be obtained, identified, and recorded under the supervision of the Supervising Engineer and the results sent to the Supervising Engineer within five days.

After connection of ground rods to each manhole’s grounding mat, the Contractor shall obtain a ground resistance measurement from a flush ground plate. These data shall be obtained, identified, and recorded and the results sent to the Supervising Engineer within five days.

The ground resistance measurement data may indicate that additional ground rods are required. The Contractor shall furnish, install, and connect additional ground rods as the Supervising Engineer may direct.

D. Operation Control

The Supervising Engineer will establish a system of operation control as the permanent equipment and systems are completed and capable of energization.

The system will consist of placing appropriate tags on each item of equipment and each system component indicating its current status and requiring mandatory clearances from designated personnel to operate, energize or remove from service the equipment or systems. The controls established will encompass the following phases:

1. Equipment or systems completed to the point where they may be energized, pressurized or operated but not yet checked out will be tagged and the sources of power or pressure will be turned off and tagged. The affected components shall not be operated without clearance.
2. Following initial operation of the equipment or system, tagging will be performed as in 1 and the affected components shall be operated only by the personnel designated by the Supervising Engineer.
3. Equipment and systems released for service will be so tagged. Only the personnel so designated by the Supervising Engineer shall operate or remove from service such systems or equipment. When a request to remove from service is made, all controls and sources of power or pressure will be tagged out and shall be operated under any circumstances. Only the personnel originally tagging the system shall clear the system from service.

The Supervising Engineer will establish the procedures and details of the operation control system. All notification of status and requests for clearances for operations shall be made to the Supervising Engineer. The procedures established shall be followed.

END OF SECTION

SECTION 16110
RACEWAYS & TRUNKING

PART 1 - GENERAL

1.1 GENERAL

A. Raceways shall include all cable ladders, trays and cable trunking with all associated accessories, supports and fixings used for the distribution of electric power in the buildings.
B. Raceways shall be of galvanized steel.

1.2 RELATED WORKS SPECIFIED ELSEWHERE

A. Section: Cables & Wires
B. Section : Supporting Devices

1.3 SIZE SELECTION

The size of the raceways shall be selected according to regulations taking into consideration required "2D" spacing between cables (Where D is the cable diameter of the larger cable) or the space factor as applicable in case of cable trunking.

PART 2 - PRODUCTS

2.1 CABLE TRAYS

A. Cable trays shall be heavy duty, return flange, of **2mm** gauge perforated type formed from sheet steel to B.S. 1449 - Part 1 and **hot-dip** galvanized after manufacture in accordance with B.S. 729.

B. Cable trays shall have a minimum **thickness** of **1.5** mm for trays up to **300**mm and **2** mm for wider trays.

C. Cable trays shall be assembled complete with couplers, bends, tees, risers, reducers and all other accessories as required and these accessories shall be of the same material, thickness and finish as the trays. Manufacturer's standard accessories shall be used and site fabrication shall only be allowed where special sections are required subject to the approval of the Engineer.

D. Mushroom head steel roofing bolts and nuts to B.S. 1494 - Part 1 shall be used to fix adjacent sections of cable trays and/or accessories. Holes cut in trays for passage of cables shall be provided with grommets. Cable trays shall be cut only along a line of plain metal and not through perforations. All cut edges of trays shall be prepared with burrs and sharp edges removed prior to installation and any cutting and/or damage made good with rust proofing agent and **zinc rich epoxy paint**.

E. Cables shall be installed on trays in a single layer except where specified otherwise, leaving 25% of the tray width space for future use.

2.2 CABLE TRAY SUPPORTS AND RACKS

A. Cable trays shall be fixed by support channels and hanger rods or by cantilever brackets fixed to walls or columns. Fixings shall be disposed at regular intervals not exceeding 0.9m (unless otherwise indicated by the manufacturer). Joints shall be positioned as close as practicable to the tray fixing or support. Mid-span joints shall be avoided. All screw bolts and nuts used for fixing shall be zinc plated to B.S. 1706 - Class B coatings. All the supporting angles, brackets, anchors, etc. shall be of hot dip galvanized. A minimum clear space of 25mm shall remain at the wall side.

B. Weld gun stud fixing will be allowed subject to the approval in writing of the Engineer. Drilling of building structural steelwork shall not be allowed except in special circumstances and then only with prior permission in writing by the Engineer.

2.3 CABLE LADDERS

A. Cable ladders shall be **H-type** made from **2mm** mild steel with **3**mm coupling plates. Side channels shall be strengthened by reinforcing inserts or other means to increase torsional rigidity. Rungs shall be slotted type. Cable ladders shall be hot-dip galvanized and shall be complete with coupling pieces, bends, tees, reducers, risers, drop-outs, intersections and all other accessories as required and these shall be of the same material, thickness and finish as the ladders.

2.4 CABLE TRUNKING

A. Cable trunking shall comply with British Standard 4678 and consists of butting sections generally not less than 2000mm long manufactured from sheet steel with stove enamel finish. The lids shall be made from the same material and shall be removable over the whole length of the trunking and secured at centers not greater than 500mm with cadmium plated cup- headed brass screws.

These screws shall locate into tapped holes in the trunking. The trunking shall be provided with lips on its opening side to form a tray and clips shall be inserted at centers not greater than 500mm to retain the cables in position when the lid is on the side of the trunking.

Adjoining sections of trunking shall butt tightly and shall be joined by means of an internal fishplate connector attached by not less than eight cadmium plated steel cup-headed bolts and hexagon nuts, passing through clearance holes. Two pairs of bolts on either side of the joint shall be connected by tinned copper braids with split soldering washers under the nuts to provide electrical continuity across the joints. The trunking shall be mechanically and electrically continuous throughout. Where trunking is used to carry various services it shall be sub-divided into three separate compartments for power, telephones and auxiliary services.

2.5 OUTDOOR CABLE TRAYS

A. Responsibility of supply and installation shall be as indicated on Drawings.

B. Assemble cable trays sun shaded cable trays (cover) for outdoor complete with couplers, bends, tees, risers, reducers and all other accessories and of the same material, thickness and finish as the trays. Use manufacturer's standard accessories. Site fabrication will be allowed only where special sections are required and subject to the approval of the Engineer.

C. Use mushroom head steel roofing bolts and nuts to B.S. 1494 part 1 to fix adjacent sections and cable trays and/or accessories. Holes cut in trays for passage of cables shall be provided with grommets to B.S. 1767, otherwise

They shall be bushed or lined. Cut cable trays only along a line of plain metal and not through perforations. Prepare all cut edges of trays and remove all burrs and sharp edges prior to installation and treat with zinc rich epoxy paint.

D. Fix cable trays by pedestals or support channels and hanger rods or by cantilever brackets fixed to walls or columns. Fixings shall be disposed at regular intervals not exceeding 0.7m (unless otherwise indicated by the manufacturer), and at 225mm from bends and intersections. Avoid mid- span joints. All screw bolts and nuts used for fixing shall be zinc plated to
B.S. 1706 Class B coatings.

E. All supporting materials, angles etc. shall be hot dip galvanized.

F. All cable trays exposed to sun shall be provided with sun-shade cover. Sun shade shall be galvanized, on-corrosion steel and shall be supported at least 10cm above cable tray, and should have 2 side slope along the cable tray.

2.6 HANGER RODS

Galvanized steel rods of minimum 10mm dia. in one piece continuously threaded shall be adopted as hanger rods for cable trays, trunking, ladders etc.

PART 3 - EXECUTION

3.1 GENERAL

All installation work shall be as per local authority’s rules and regulations. Where no local authority’s regulation is available, IEE wiring regulations shall be followed.

3.2 CABLE TRUNKING

- All trunking shall be properly aligned and shall run parallel or right angles to walls and the ceiling beam.
- The trunking shall be supported at not more than 0.7 m. All supports shall be galvanized.
- The trunking ends shall be properly closed.
- Earth continuity shall be provided at points through braided copper tape.

3.3 CABLE TRAYS

- Cable trays shall not sag more than 3 degrees between supports
- Cable trays shall be supported at not more than 80 cms by galvanized wall brackets/supports or by stainless steel hanger rods.
- Cable trays shall not be cut through perforations.
- Earth continuity shall be provided at points through braided copper tape.

3.4 SEALING (FIRE BARRIRES)

Fire resisting caulking compound for sealing trays, trunking, conduits, cables, ducts, pipes and sleeves shall be of a putty like consistency workable with hands. All materials for caulking and sealing shall be approved by Civil Defense wherever applicable.

3.5 RETAINERS

Cable retaining straps or cable ties shall be used as applicable to the raceways and shall generally be spaced 100cms.

END OF SECTION

SECTION 16120
CONDUITS

PART 1

1.1 GENERAL

PVC conduits shall generally be allowed in CAST-IN-SITU and above false ceiling. Surface installed Conduits (below false ceiling and on exposed ceiling) shall be rigid steel (GI). Where heavy protection against mechanical damage is required only rigid steel (GI) conduit shall be used.
All conduits and conduit fittings shall comply with concerned local authorities Specifications.
In precast concrete slabs etc. GI conduits shall be used.

1.2 CONDUIT SYSTEM

Conduit system shall be provided including all necessary fittings, supports, accessories, all other hardware complete as required.

For underground installation UPVC conduits shall be used.

All materials for caulking and sealing conduits, pipes, sleeves etc. through fire rated Walls or floors, shall be approved by the concerned local authorities as similarly applicable to cable trays and Trunking.

1.3 RELATED WORKS SPECIFIED ELSEWHERE

A. Section 16200 Cables & Wires
B. Section 16300 Wiring Devices

1.4 SUBMISSION

A. Cut away samples with manufacturer's details.
B. Shop drawings of proposed conduit layouts.

PART 2

PRODUCTS

2.1 STEEL CONDUITS (G.I Conduit)

Steel conduits shall be heavy gauge steel conduit hot dip galvanized inside and outside. The steel conduits, all junction boxes and other accessories shall be accordance with British Standard 4568 Parts 1 and 2 and shall be Class 4. The internal diameter of conduits shall be not less than 20mm.

All conduit boxes shall be constructed in malleable iron and in accordance with British Standard 31 Class B in the case of standard junctions or Class B5 where conduit is looped from point to point. All conduit work shall be so arranged to permit wiring to be drawn in after completion of conduit work. Where conduit work is concealed above suspended ceilings or in other building finishes the wiring shall be possible without disturbance to the building finishes. The conduit work at lighting points shall always be terminated in a standard or loop-in junction box and such boxes shall be firmly secured to enable the luminaire to be fixed to the lugs of the conduit box and be suspended therefore without other support. Where conduits are terminated in a box without a screwed spout the junction shall be made by means of a coupling and an external thread brass bush with hexagon head.

In general, conduits shall be concealed within the building structure, behind suspended ceilings, within partitions, in floor screeds or plaster finishes. No conduit work shall be exposed on the surface unless this is specified or in services plant rooms. All external work shall be carried out using galvanized steel conduit and accessories. The installation shall be electrically and mechanically continuous throughout and where polyvinyl chloride conduit is utilized this shall be achieved by the use of a separate polyvinyl chloride insulated earth wire installed throughout the conduit run with terminations being made in conduit boxes or metal enclosures of apparatus. All conduit ends shall be reamed to remove sharp edges and threads shall be of sufficient length to enable conduits to butt within couplings or to the stop end in box spouts. Draw-in boxes on straight runs shall be provided at no more than 9000mm centers. Where right angle bends are formed in the circuit, draw-in boxes shall be provided at not more than 7500mm centers and not more than two right angled bends shall be employed in any one run. Where conduit work is run external to the buildings a drain hole of 3mm diameter shall be drilled in the bottom of switch boxes and other low points to drain condensation. Conduits shall be fixed by means of spacing saddles on rough concrete or brickwork. On fair faced brickwork or plaster spacer-bar saddles may be used. Saddles shall be spaced at internals of not more than 1300mm on straight runs and not more than 200mm on either side of a bend or junction box. Fixings shall be made by means of galvanized steel wood screws of not less than 3mm diameter and 40mm in length, screwed into plastic or fiber insert plugs. All lighting point boxes, switch boxes or socket outlet boxes shall be fixed by means of two 8 gauge x 40mm steel screws.

2.2 PVC CONDUITS (HEAVY GAUGE ONLY)

All rigid PVC conduit and conduit fittings shall conform to British Standard 4607 are to be certified as suitable for use at ambient temperatures up to 55 deg.C. Additionally, the material shall not soften or suffer any structural degradation at a temperature of 85 Deg.C and shall be non-hygroscopic and self-extinguishing type.

All boxes and extension rings shall be fitted with brass inserts for the securing screws and with an earth terminal. Conduit fittings and accessories shall be of the same manufacture and shall be of the unthreaded type.

The internal and external surfaces of conduits shall be smooth and free from burrs and similar defects. The interior and ends of conduit fittings shall be free of sharp edges and corners and shall be smooth and well-rounded to permit easy drawing in of cable and to prevent any damage to cable insulation.
Boxes in ceiling for lighting/fans etc. shall be of GI type.

The PVC conduits shall be installed generally in accordance with the requirements set out for metal conduits. Additionally the method of supporting PVC conduits shall allow for the longitudinal expansion and contraction of the conduit.

2.3 CONDUIT (FLEXIBLE CONNECTIONS)

Where conduit work has to be terminated with a flexible connection, as in the case of motors, the rigid conduit shall be terminated in a box adjacent to the motor and the connection between this box and the motor junction box made in flexible conduit. This shall be corrosion resistant flexible metal tubing with a polyvinyl.

Chloride sheath terminated at each end by a compression gland screwed into the connection boxes.

2.4 CONDUIT (CAPACITY)

The number of polyvinyl chloride single core cables run in any one conduit shall be restricted in accordance with concerned local authorities Regulations (latest Edition).

Where three-phase circuits are run in conduit all three phases and the neutral of the circuit shall run in the same conduit.

2.5 METALLIC CONDUIT BOXES FOR EXTERIOR LOCATIONS

All boxes installed in exterior locations, plant rooms, ducts etc, shall be fitted with approved type gaskets to provide a waterproof seal between box and cover or other item fitted to the box.

PART 3 EXECUTION

3.1 PVC conduits and fittings shall be joined by using sealing cement (vinyl solvent paint) to ensure a watertight joint. The cement shall be of a type that remains in a sticky condition. When PVC conduits are embedded in concrete slabs, they shall be securely held in place by fixing to shuttering and reinforcing bars. In walls, they shall be run in cut chases and fixed by saddles or crumpets.

3.2 Chases shall be deep enough to allow full thickness of plaster cover to be applied. Bends in PVC conduits shall be neatly made with a proper size bending spring.

3.3 Except when embedded in concrete slab, all conduits shall be installed parallel to the lines of the building and at a minimum of 100mm away from pipes or other non electrical services. Boxes shall be fixed independently to the building so as not to be supported by the conduits. Empty conduits when left with ends exposed for some time shall be closed with suitable plugs to prevent entry of dirt and foreign matter.

3.4 Conduits shall be installed in such a manner to prevent trapped condensation. Pull boxes shall be provided as required for easy drawing of wires and shall be in readily accessible locations with covers fixed by brass screws.

3.5 No wire is to be drawn inside conduits until they are completely erected and approved by the Engineer. The conduits shall be swabbed through to remove any dirt or loose matter before drawing of wires.

3.6 The sizes of conduits shall be in accordance with the number and sizes of wires to be drawn inside them as indicated in IEE or latest concerned local authorities' regulations, but no conduit smaller than 25mm shall be used. A pull wire or tape shall be provided in all empty conduits with no less than 200mm of slack left at each end.

3.7 Flexible conduits shall be used for connection of motors, HVAC equipment, recessed light fittings ...etc. Fixed conduits shall be terminated in a conduit box and flexible conduit shall then connect to the equipment.

3.8 For flexible conduit on earth wire shall be wound around the flexible conduit and connected at each end to earth terminal.

The conduit system shall, in general, be surface mounted in all plant rooms, electrical rooms and in Service Tunnel.

END OF SECTION

SECTION 16200
CABLES AND WIRES

PART 1 – GENERAL

1.01 DESCRIPTION

A. The work to be performed includes, but is not necessarily limited to, all work involved with the supply and installation of wires and cables and the associated connectors and terminal boards used in electrical power distribution systems.

B. The types of wires and cables specified in this section include the following:
   1. Power cables (Insulated & Sheathed)
      A. Single Core PVC insulated and sheathed 600/1000V cables.
      B. Single core XLPE insulated PVC sheathed (600/1000V) cables.
      C. Multicore PVC cables (600 / 1000V) non-armored cables.
      D. Multicore PVC / SWA / PVC cables (600/1000V).
      E. Multicore XLPE / PVC (600/1000V).
      F. Multicore XLPE / SWA / PVC (600/1000V).
   2. Small power and lighting cables (Insulated)
      A. Single core PVC insulated cables (450/750V).
   3. Signal / Instrument cables.
   4. Data transmission cables.

1.02 QUALITY ASSURANCE

A. The Contractor is responsible for the quality of all purchased items and as such must develop and submit a supplier Quality Inspection Plan for review- The inspection plan shall cover those items intended for shop inspection and the procedures for carrying out same.

B. Manufacturer: Cables and wires shall be the products of a manufacturer regularly engaged in manufacture of cables and wires of types and sizes required and complying with the requirements of the listed standards and whose products have been in satisfactory use in similar service for not less than 5 years.

C. Codes and Standards: Comply with requirements of the latest edition of the following codes and standards except as herein specified:
   1. BSI - British Standard Institution:

BS 1442	Specification for galvanized mild steel wire for armored cable.
BS 4109	Specification for copper for electrical purposes. Wire for general electrical purposes and for insulated cables and flexible cords.

BS 5308	Instrumentation Cables
BS 5467	Specification for cables with thermo-setting insulation for electricity supply for rated voltages of up to and including 600/1000V and up to and including 1700/3300V.
BS 6004	Specification for PVC insulated cables (non-armored) for electric power and lighting.
BS 6007	Specification for rubber-insulated cables for electric power and lighting.
BS 6081	Specification for terminations for mineral insulated cables.
BS 6121	Mechanical cable glands
BS 6207	Specification for mineral insulated copper-sheathed cables with copper conductors.
BS 6234	Specification for polyethylene insulation and sheath of electric cables.
BS 6346	Specification for PVC insulated cables for electricity supply.
BS 6360	Specification for conductors in insulated cables and cords.
BS 6469	Methods of test for insulation and sheaths of electric cables.
BS 6500	Specification for insulated flexible cords and cables.
BS 6746	Specification for PVC insulation and sheath of electric cables.

1.03 TESTS AND ACCEPTANCE CRITERIA

A. Field testing: Prior to energization, cables and wires shall be checked for the following:
   1. **Continuity of circuitry.**
   2. **Short circuits.**
   3. **Insulation resistance test**, including procedure, equipment required (such as 500V megger) and acceptable values for resistance in accordance with recognized standards.

B. Malfunctions shall be corrected when detected.

C. Subsequent to wire and cable hook-ups circuitry shall be energized and circuits tested for performance in accordance with all requirements.

D. Factory test as per listed standard.

1.04 SUBMITTALS

A. The Contractor shall submit to the Engineer the required documents to establish compliance with this section. Submittal shall include at least the following:

1. Manufacturer's Data: Including specifications, installation instructions dimensions and general recommendations for each type of cable.
2. Shop Drawings: Dimensioned drawings of cables routing showing accurately layouts of cables installation and their special relationship to associated equipment and details of installation.
3. Across sectional drawing of the cable bedding, sanding, tiles, warming, back fill.
4. Test Certificates: Manufacturer shall submit against each drum, the following certificates:
   a. High voltage DC insulation pressure test, between cores each core to earth metallic sheath or armor as applicable.
   b. Insulation resistance test
   c. Core continuity and identification
   d. conductor resistance test

B. The Contractor shall submit to the Engineer in accordance with the provisions.

PART 2 - PRODUCTS

2.01 GENERAL

A. Cables shall be manufactured and tested to the latest relevant British or harmonized European Standards or IEC.

B. The cable sheath shall be marked with the information required by the relevant BS, BS EN or IEC.

C. Cables shall be delivered, stored and handled in accordance with the manufacturer’s instructions. Where the performance of the cable is likely to be adversely affected by the ingress of moisture, it shall be adequately sealed at either end.

D. Unless otherwise specified, the outer sheath of all cables shall be coloured black for grade 600/1000 V with the exception of the following:

   1. Protective conductors: - Green/yellow; and
   2. Intrinsically safe: - Blue

E. Cables shall have copper conductors to BS 4109/BS 6360. Cores of cross sectional area greater than 2.5 mm2 shall be stranded or flexible.

F. The scheme of wiring shall conform to the color code requirements of BS 7671.

G. Cables shall be delivered, stored, and handled in accordance with the manufacturer's instructions. Where the performance of the cable is likely to be adversely affected by the ingress of moisture, it shall be adequately sealed at either end.

H. The general routing of cables shown on the Drawings is indicative of the final routes and duct locations shall be agreed with the Engineer before any work in connection with the cable installation is commenced. All cables shall be installed in strict accordance with the requirements of this Specification.

I. All cables used shall bear the manufacturer's original guarantee and all cables shall be delivered to Site in their original wrappings.

2.02 SINGLE CORE PVC INSULATED AND SHEATHED CABLES

A. This type of cable shall be 600/1000V grade, complying with BS 6346 and shall have stranded conductors of plain annealed copper wires.

B. The conductor shall be PVC insulated.

C. Over the insulated conductor an outer protecting layer of extruded PVC layer shall be applied.

2.03 SINGLE CORE XLPE INSULATED AND PVC SHEATHED CABLES

A. This type of cable shall be 600/1000V grade, complying with BS 5467 and shall have stranded conductors of plain annealed copper wires.

B. The conductor shall be XLPE insulated.

C. Over the insulated conductor an outer protecting layer of extruded PVC layer shall be applied.

2.04 MULTICORE PVC/PVC 600/1000 V NON-ARMOURED CABLES

A. This type of cable shall be 600/1000V grade complying with BS 6346. The core shall have stranded conductors of plain annealed copper wires.

B. The cores shall be PVC insulated and the cores insulation shall be colored for identification as per BS 7671.

C. The assembled cable shall be bedded with a layer of extruded PVC in order to fill the interstices between the cores.

D. A black outer protecting layer of extruded PVC shall be applied over the bedded cables.

2.05 MULTICORE PVC/SWA/PVC 600/1000V ARMOURED CABLES

A. This type of cable shall be 600/1000 grade complying with BS 6346, multicore. The core shall have stranded conductors of plain annealed copper wires.

B. The cores shall be PVC insulated and the cores insulation shall be colored for identification as per BS 7671.

C. The assembled cable shall be bedded with a layer of extruded PVC in order to fill the interstices between the cores.

D. Over the bedding is helically applied a layer of galvanized steel wires in such a way to form a continuous metallic protecting cover.

E. Over the armored cable, an outer black protection layer of extruded PVC shall be applied.

F. A single core cable shall have aluminum wire armor.

2.06 MULTICORE XLPE/PVC 600/1000V NON-ARMOURED CABLES

A. This type of cable shall be 600/1000V grade complying with BS 5467, multicore. The core shall have stranded conductors of plain annealed copper wires.

B. The cores shall be XLPE insulated and the core insulation shall be colored for identification as per BS 7671.

C. The assembled cable shall be bedded with a layer of extruded PVC in order to fill the interstices between the cores.

D. A black outer protecting layer of extended PVC shall be applied over the bedded cables.

2.07 MULTICORE XLPE/SWA/PVC 600/1000V ARMOURED CABLES

A. This type of cable shall be 600/1000 grade complying with BS 5467, multi-core. The core shall have stranded conductors of plain annealed copper wires.

B. The cores shall be XLPE insulated and the cores insulation shall be colored for identification as per BS 7671.

C. The assembled cable shall be bedded with a layer of extruded PVC n order to fill the interstices between the cores.

D. Over the bedding is helically applied a layer of galvanized steel wires in such a way to form a continuous metallic protecting cover.

E. Over the armored cable, an outer black protection layer of extruded PVC shall be applied.

F. A single core cable shall have aluminum wire armor.

2.08 SINGLE CORE PVC

A. Cables shall comply with BS 6004, IEC 60227 and be rated at 450/750V.

B. The insulation shall be PVC phase coloured.

2.09 SIGNAL AND INSTRUMENTATION CABLES

A. Instrumentation cables unless otherwise indicated, shall be rated 300/500 V and comply with BS 5308 type 2.

B. Cables shall be PVC or polyethylene insulated twisted pair with individual or collective metallic foil screen, tape bound with extruded PVC bedding, galvanized steel wire armouring and colored overall PVC sheath. Conductors shall be multistring copper, 24/0.2 mm (0.75 mm2) or as indicated.

C. Collection screened cables shall be used only with measuring transmitters and analogue controllers (4-20 m Adc) up to 30 m route length.

D. Individual and collective screened cables shall be used:

E. For circuits as in (1) but exceeding 30 m route length and for inputs to data loggers, telemetry systems, microprocessors, computer, also cable to transducers.

2.10 DATA TRANSMISSION CABLES

A. Defined as extra low voltage, digital signaling cables between computers, programmable logic controllers (PLCS) and remote telemetry units (RTUS) and other data transmission equipment.

B. The minimum cross sectional area of cable conductors shall be 0.5 mm2.

C. The following types of cable may be used unless otherwise indicated:

1. Those complying with BS 5308: Parts 1 & 2;
2. Belden or equivalent;
3. STP Category 6A; and
4. Those specified by the equipment manufacturer.

PART 3 - EXECUTION

3.02 INSTALLATION OF CABLES GENERAL

D. All cables shall be installed in accordance with the applicable provisions of BS 7671/IEC 60364 and as indicated on the drawings.

E. Detailed wiring diagrams including designations, tagging marks, labeling, etc, shall be submitted for approval before implementation.

F. The number and sizes of wires and conduits indicated on the drawings are for guidance only. It is the contractor's responsibility to supply and install the exact number and sizes of cables required by the equipment to be installed and to provide the right size conduits for the number of cables at no extra cost to the owner.

G. Each cable shall be supplied in a suitable length and be continuous through its run where adequate manufacturer lengths are available through joints will not be permitted without the permission of the Engineer.

H. Every cable whether in or out sight shall be neatly run vertically, horizontally or parallel to adjacent walls, beams or other structural members.

I. Cables installed in groups shall run in straight lines and not cross over each other.

J. Cables which may be subject to accidental mechanical damage shall be suitably protected by cable guards.

K. Where cables are surface run on the external faces of structures or above ground level, suitable protection from the radiation of the sun shall be provided by means of covers or canopies.

L. The protection covers or canopies shall be of an approved design, securely fixed to the structure or ground and be fully ventilated.

M. All cables shall be delivered on robust cable drums with cable ends treated to form an effective seal when a cable is cut from a drum the cable end left on the drum shall be immediately sealed in an approved manner to prevent the ingress

N. All cable hangers, cleats, saddles, brackets and similar supporting devices shall be of an approved type and of adequate strength for the cable they are supporting. They shall be treated to withstand site conditions without corroding.

O. Spacing of clips, saddles and cleats shall be such to prevent sagging of the cable at all times during their installed life.

P. All power shall be connected to main switchboards and other items of plant so that the correct phase sequence and phase color coding are preserved throughout the system. All such cables shall be identified with phase colors for 3 & 4 wire systems and blue and brown for single phase. On rotating plant where to achieve the required direction of rotation it is not possible to connect the phase cores to the appropriately identified terminals then special core ferrules shall be fitted to identify each core with the terminal to which it is finally connected.

Q. The general routing of cables shown on the drawings is indicative the cables shall be installed as per the approved shop drawings.

R. Cables and their support systems shall not be fixed to protective barriers, guards or directly to hand railing.

S. Before making of a termination, the Contractor shall ascertain whether special phasing conditions apply and shall be responsible for ensuring that all connections are correctly phased out.

T. The Contractor shall be responsible for obtaining drawings of all boxes or apparatus into which cables are terminated and shall ensure that the design is suitable for the use with the cables supplied under this Contract.

U. Cables passing through floors shall be installed in the manner specified and where required shall be sealed into bushes employing fire resisting material to minimize the risk of spreading fire.

V. In all instances where cables enter building or ducts, they shall be installed into not less than 100 mm diameter duct pipes. The ends of the pipes shall be sealed with cold plastic compound. Where cable enter below floor level the pipes will terminate in a floor recess which shall be filled with sand and covered with a thin layer of concrete, after cabling.

W. Where cables are run within ducts, or along the surface of walls, they shall be supported by approved heavy gauge galvanized cable tray or ladder.

X. In positions where cables rise vertically, in ducts or on the face of walls etc., they are to be fixed by means of approved cleats and spaced as recommended by the cable manufacturer.

Y. All cables shall be adequately supported and run clear of heating pipe.

Z. The wiring shall generally be carried out on the loop-in system at accessory points only. The use of junction boxes will not be permitted.

AA. Generally, all cables shall be concealed above suspended ceiling and it is intended that these shall be installed before any ceiling board is erected or plastering carried out.

BB. Cables run in floor voids and roof space, where run parallel with the joists, shall be fixed to the joint side and where run at right angles shall be supported by cable trays. Care shall be taken to prevent the cables being subjected to pressure or mechanical strain at bends and changes in direction. Easy bends and rounded supports shall be employed at all such positions. The inside radius of any bend is not to be less than 8 times the overall diameter of the cable.

CC. All cables shall be prevented by spacing, insulation, or other means from coming into contact with water pipes, telephones and bell installed.

DD. Cables run in roof space shall be laid on cable trays or ladders.

EE. The cables shall be run and terminated otherwise as specified and as unobtrusive, neat and symmetrical as possible.

FF. Industrial area

1. In the industrial areas like Main Workshop, Generator Halls, Main Transformer Chamber, Riser Shaft, the conduits shall be rigid metallic type surface mounted.
2. The small rower and lighting cables (Insulated only) shall be installed in conduits
3. The Power cables (Insulated and sheathed) shall be clipped to the wall or installed on cable trays.
4. Power cables in floor trench shall be installed on galvanized cable ladders.

GG. Commercial area

1. In the commercial areas the conduits shall be of the non-metallic rigid type in the wall or above the suspended ceiling.
2. The small power and lighting cables shall be installed in conduits.
3. The power cables above the suspended ceiling shall be clipped to the wall or installed on cable trays.
4. The power cables in the walls shall be installed in rigid non-metallic conduits embedded in walls.

3.03 CABLE TERMINATIONS AND JOINTS

A. Where more than one cable is to be terminated at an item or equipment, particular care should be taken to ensure that all cables to that equipment are routed from a common direction and each is terminated in an orderly and symmetrical fashion

B. The Contractor shall supply and install all necessary cable glands and sealing boxes required to complete the installation. All materials used in the manufacture of the glands etc., shall have no deleterious effect on the cable core or armoring and shall not be susceptible to corrosion.

C. The cores of each cable shall be taken direct to the terminals of the equipment to be connected. Cable ends shall be sealed in suitable chambers bolted to terminal boxes. Compression glands with armor clamps where required are to be supplied as an integral part of switchboards, distribution boards, switches, motor starter and similar equipment unless other stated.

D. Wherever it is necessary to remove the PVC sheath of a cable (e.g. at a joint) the minimum length necessary shall be removed and the exposed copper sheath or armoring shall be adequately covered by a PVC tape or sleeve or other suitable means.

E. PVC or XLPE insulated cables shall be terminated with mechanical glands in accordance with BS 6121 and shall be of the type to provide adequate support to the cable by under and over locking on the cable armoring, giving a high earth continuity. Each and every mechanical cable gland shall be supplied and installed complete with brass earthing tape and a PVC gland shroud, which shall provide an effective seal on both the cable over sheath and gland.

F. All cable conductors shall be terminated in suitable copper lugs or brass thimbles which shall be attached to the conductors by use of a pneumatic crimping machine using the correct crimping dies for each size of cable core.

G. Where single core glands are required, these shall be non-magnetic. The gland plate shall also be of a nonmagnetic material. Removable connections for bonding across the gland insulation shall be provided. The gland insulation shall withstand a test of 2 kV ac for one minute

H. Aluminum cores of power cables shall be terminated using approved bimetallic connectors.

I. All glands shall be provided with an earthing tag. Glands shall comply with BS 6121. They shall seal the inner and outer cable sheaths against ingress of dirt and moisture and provide mechanical support.

J. Where cable glands are exposed to the weather, these shall be protected by heat shrink plastic tape or purpose molded sleeves covering the gland continuously from overall sheath to the gland neck.

K. Where the apparatus enclosure classification requires sealed cable gland entries, sealing shall be achieved by using threaded cable gland holes and polytetrafluoroethylene (PTFE) tape.

L. Multicore or control cable terminations

1. A sufficient number of terminals shall be provided to terminate all cable cores. For control and auxiliary wiring and additional 20% of this number shall be provided as spares.
2. Terminal blocks for terminating up to and including 35 mm^2 cable shall securely clamp the conductor, without damage, between two plates by means of a captive screw; pinch screw type terminal blocks shall not be used.
3. For cables above 35 mm^2, stud or bolted terminals shall be used, each cable core being fitted with a suitable lug.
4. Not more than one core of internal or external wiring shall be connected on any terminal. Where duplication of terminal blocks is necessary, purpose made solid links shall be incorporated in the design of the terminal blocks.
5. Terminals which remain energized when the main equipment is isolated shall be suitable screened and labelled.
6. Plant which has to be dismantled for maintenance shall have multicore cable terminations made of tough glands onto an adaptable box. The box shall have terminal blocks, and connections shall be made to the equipment by single core wires and flexible waterproof plastic conduit. A separate earth core shall link the box to the equipment.

M. Joints

Through joints shall only be allowed on long cable runs outside buildings. Where such joints are necessary in thermoplastic and elastomeric cables, the cables shall be jointed with epoxy or acrylic resin cold setting compound, which has been premeasured and prepackaged ready for use. The boxed shall be of split, moulded plastic type with filling vents for compound. Bonding straps shall be fitted with armor clamps across the joint and inspected by the Engineer prior to filling the box with compound. Conductor cores shall be jointed number to number or color to color.

3.04 CABLE AND CORE IDENTIFICATION

A. Each and every cable shall be permanently identified at each end and at entry and exit points of building's ducts by its cable number. Cable markers shall comprise oval marker with semi-rigid black PVC carrier strip and shall be fixed axially by means of two PVC covered aluminum strips with buckles.

B. Permanent corrosion resistant identification labels shall also be installed on cables at each and every entry and exit points of buried ducts, exits and entry to any structure and in such other positions as are necessary to identify and trace the route of any site cable. The use of punch type adhesive labels (Dymo-tape) shall not be permitted.

C. Control cables shall have individual cores identified by means of suitable permanent ferrules bearing the same numbers at both ends. Core identification shall occur at every point of termination using an approved system of ferrule markers. Numbering shall read from the terminal outwards on all cores. At those points of interconnection between wiring where a change of number cannot be avoided double ferrules shall be provided on each wire. The change of numbering shall be shown on the wiring diagrams of the equipment at which the change is made.

D. Where the termination of control cable cores or the supervision of termination of cores is specified as being the responsibility of another contractor (e.g. the termination of certain control and instrumentation cables) any necessary temporary means of core identification shall be agreed with that contractor. Should the Contractor propose to use junction boxes in auxiliary control cable circuits for the purpose of marshalling a number of cables feeding to a common item of equipment full details shall be given to the Engineer and the Contractor shall only proceed after receipt of the Engineer's written approval. Any such junction box shall be of the wall mounting pattern with double terminals with cores ferruled and identified in accordance with the system schematic and cable diagrams.

E. All cables shall be identified below the gland at each end and at approved positions by means of bands engraved or stamped with the cable number, feeder name, size of cable, number of cores, phase color, etc., or such lettering as the Engineer may require. The bands shall be securely fastened in a permanent manner, and shall be made of material able to resist corrosion, damp, and mechanical damage.

F. Single core cables are to be identified by colored tape over the cable above the gland.

G. Tagging

1. Where two or more circuits are run to or through a control device, outlet box or ceiling junction box, each circuit shall be tagged as a guide in making connection.
2. Conductors for which outer jacket if not color-coded shall either have an engraved identification mark or shall be tagged.
3. Tags shall identify wire or cable number, conductor size and piece of equipment served in accordance with the schedules as shown on the drawings.
4. Main and feeder cables shall be tagged in all pull boxes, wireway and wiring gutters of panels and at their terminals.
5. All control cables and power cables shall be provided with cable markers attached to the outer sheath of the cables for ease of identification, and every cable shall be labelled with the number it is allocated on the relevant cable schedule.
6. The cable markers shall be fitted to cables in an accessible position that is clearly readable, i.e.

    a. Inside a control cubicle within 100 mm of the gland position on the cable serving.
    b. At motors, junction boxes and remote enclosures, as near as possible to the gland position.

7. Additional marker labels shall be fitted where cables enter and leave cable tray, ducts pipe or change direction during a run.

3.05 SEALING

A. Cables entering or leaving ducts shall be sealed. Power and control cables shall be sealed where they enter and leave ducts at all points and in cable chambers including intermediate pulling chambers. The sealing compound shall exhibit the following properties:
    1. Adheres to all metal surfaces, unplasticised, PVC, polyethylene and glazed earthenware and to cable sheath materials.
    2. Unaffected by water.

B. The type of sealing systems used shall be agreed with the Purchaser and shall be selected and installed with due regard to environmental and hazardous area requirements. They shall be from one of the following:

    1. Approved water, gas and fire sealing transit units with fillers and insert blocks fitted to suit all cables and conduits;

2. Approved oil based, non-setting, reusable sealing compound inserted into the duct or opening around all cables and conduits. Or,

3. Approved fire retardant AND fire resistant cables, caulking compound or fiber blocks supplied in two halves and shaped to accommodate all cables and conduits.

C. Each sealing arrangement shall comply with the following requirements.
   1. It shall be compatible with the material of the wiring system with which it is in contact and
   2. It shall permit thermal movement of the wiring system without reduction of the sealing quality, and
   3. It shall be removable without damage to existing cable where space permits future extension to be made, and
   4. It shall resist relevant external influences to the same degree as the wiring system with which it is used.

D. During the erection of a wiring system temporary sealing arrangements shall be provided as appropriate.

E. Where cables pass through walls below ground level, the point of entry shall be sealed against the ingress of water. This shall be achieved with petrolatum tape and mastic, silicon foam or proprietary cable transits.

F. Where ables pass in or out of any duct entries into or within buildings such entries, together with any spare ducts shall be sealed against the ingress of moisture by means of duct stoppers and bituminous compounds or by any other method approved by the Engineer. The stopper shall have a fire resistance of at least 30 minutes.

3.06 CABLE SEGREGATION

A. Only conductors carrying signals of the same instrumentation signal category shall be contained within any one multi-core cable.

B. In each instrumentation signal category, a further segregation is required to ensure that conductors forming part of an intrinsically safe circuit are contained within multi-core cables reserved solely for such circuits.

C. High integrity signals such as data transmission or critical shut down signals shall be contained in separate cables.

D. ICA/Telemetry cables sharing a cable tray, duct or route with power cables shall be avoided power cables are defined as A.C cables above 50 volts with a 10 amp rating. Where this is not practicable, a minimum maintained separation between cables shall be provided in accordance with Table A.

E. Where the maximum current exceeds 100 amps or the voltage exceeds 650 volts, the minimum segregation shall be 1200 mm. For higher ratings the segregation shall be progressively increased, 2000 mm from a 33 kV cable is a typical figure.

F. Where the length of an enforced parallel run between power and ICA/Telemetry cables is greater than 500 meters, a progressive pro-rata increase in segregation distance shall apply.

G. The segregation distances shall be maintained by positive means and shall apply to both above ground and below ground installations.

H. Where a crossover between power and ICA/Telemetry cables is unavoidable the cable shall be arranged to cross at right angles. The number of crossovers shall be kept to a minimum.

I. Where cable installations are of a restrictive nature such as entries into buildings, panels, etc., relation of the minimum segregation distance requirement from a power cable(s) is acceptable. The minimum segregation distance shall then be the distance, determined by the length of the parallelism at the restrictive section of the installation.

3.07 CABLE IN CONDUIT

A. All conductors to be contained within a single conduit shall be drawn in at the same time. An approved lubricant may be used in drawing conductors through conduits.

B. A reasonable amount of slack shall be left in each conductor at distribution

C. boards, outlets boxes and other devices to facilitate the making of joints and connections to fixtures and equipment.

D. Branch circuits shall be properly balanced on the buses of distribution boards.

E. Single core cable shall be drawn into conduit or trunking with multicore cables laid on trays or run on surfaces to which they are affixed as a continuous length between points of termination. The use of junction boxes will only be permitted with the written approval of the Engineer.

F. Single core cables run in conduit or trunking shall be limited in the number contained in each conduit or trunking in accordance with the grouping allowed in calculating their current rating and the maximum containment in accordance with BS 7671.

G. Circuits supplied from different distribution boards shall not be installed in the same conduit.

H. Final sub circuits shall not be installed in the same conduit as sub mains circuit.

I. DC circuits shall be run in separate conduits.

3.08 CABLES ON LADDERS/TRAYS

A. Cables shall be supported to avoid damage during installation, prior to dressing and fixing.

B. Cables shall be securely fixed to ladder/trays

C. For cables installed in accessible positions, where the entire support for the cable is derived from clips, the maximum spacing of clips shall comply with IEE Guidance Note No.1: Selection and Erection, Appendix 1.

D. Depending on their overall diameters, single cables and groups of cables shall be secured according to the applicable standard.

E. In outdoor locations, where installation could be subject to ultra violet light, PVC covered aluminum tape shall be used in preference to nylon cable ties.

F. Cables installed in groups shall be installed in straight lines and not cross over each other. Cables shall not be installed in more than two layers, comprising a maximum group size of 7.

G. Where cables leave trays shall be covered with PVC or formed to present a smooth surface to prevent damage to the cable.

H. Single core power cables shall be secured throughout using proprietary trefoil cable cleats.

3.09 CABLES IN TRUNKING

A. In order to prevent damage to cables during installation, cables shall not be installed into any section of trunking until that section has been completed.

B. The trunking shall provide 10% spare rated capacity.

C. Cables of individual circuits shall be taped together, at 1500 mm intervals, along their length to avoid damage to cables in trunking mounted other than lid up and particularly in all vertical runs and at bends, proprietary cable retainers/supports/pin racks/cable guides shall be used.

D. Trunking shall be terminated using proprietary fittings.

3.10 CABLES TRENCH WORK

A. Cables Routes: The Contractor shall prepare drawings to scale showing the cables routes and method of installation. He shall draw up diagrams indicating sizes and types. These drawings shall be submitted to the Engineer.

B. The arrangement of the cables and all methods of laying shall be approved by the Engineer and shall be planned to provide an orderly formation, free from unnecessary bends and crossing, which will permit the removal of any one cable without undue disturbance to adjacent cables. No joints shall be allowed in any cable unless approved by the Engineer.

C. The proposed trench route shall be surveyed for the presence of underground cables and/or services before digging commences.

D. Machine digging shall not be permitted within1 m of suspected cable positions.

E. Lines of trenches shall be kept as straight as possible.

F. Trenches shall have vertical sides supported to avoid subsidence. Where a change in ground level is necessary, the bottom of the trench shall rise or fall gradually.

G. To ensure that trench bottoms are firm, smooth and free of loose stones and debris, they shall be lined with approximately 200 mm of sand or other approved material.

H. The trench backfill shall be compacted in layers of a maximum thickness of 200 mm and the surface reinstated to a condition not inferior to that of the surrounding ground.

I. When excavations for trenches have been accurately executed, notice shall be given by the Contractor to the Engineer. Laying of cables or building of structures shall not be started until the Contractor has obtained the Engineer's sanction to proceed with the work.

3.11 INSTALLATION OF DIRECT BURIED CABLES

A. The excavation and backfilling of cable trench work shall be carried out by the Contractor.

B. The Contractor shall supply and lay the sand bedding, cables, sand blinding, cable cover tiles and marking tape. He shall also

supply and lay cable route marker posts after the backfilling and top soiling, has been carried out.

C. The sanding and laying of all cables shall satisfy the following requirements:
   1. Cable depths shall be assessed from the finished ground level unless otherwise directed by the Engineer.
   2. L.V. cables shall be laid at a depth of 0.6 meter.
   3. H.V. and L.V. cables may be run in the same trench but should be staggered. However, where necessary to pass through ductwork, cables shall be laid vertically above each other with the H.V. cables at the lowest level with a good sand blinding forming the sand bedding for the L.V. cables.
   4. Before laying in cables the Contractor shall inspect the trench work to ensure that the trench bottom is of a smooth and firm contour and free from all sharp materials or obstructions.
   5. Cable bedding within the trenches shall be formed by a 200 mm sand layer.
   6. Cables shall be laid with adequate separation and shall be <<snaked>> to avoid tension during backfilling operations and subsequent settlement.
   7. Before sanding and backfilling, all laid cables shall be inspected by the Engineer, and a further inspection following sanding and tiling shall be made by the Engineer before backfilling.
   8. After cables have been laid, they shall be covered by a further 200 mm of sand which shall be well tamped around the cables. Mechanical pruners shall not be used for this work.
   9. After sanding cable cover reinforced concrete tile inscribed "ELECTRIC CABLE" shall be of adequate width to ensure an overlap of 150 mm on each side of the cable or group of cables protected. Where two or more tiles are required to protect a group of cables, the longitudinal joint between adjacent tiles shall be at least 50 mm from the nearest cable.
   10. A bright yellow or orange colored plastic tape 150 mm wide by 0.1 mm thick shall be laid in a continuous manner above the center of each 300 mm width of trench, 150 mm below ground level. The tape shall be continuously indelibly marked in Arabic and English with the words.

       - **DANGER ELECTRIC CABLE**

   11. Care shall be taken to ensure complete continuity of such tape, and care taken to avoid displacement of the tape during backfilling.
   12. Cables shall be unrolled from the drums in such a manner as to avoid loops and kinks, and care shall be taken when laying to avoid damage to the outer sheath by drawing over sharp obstacles or stones.
   13. Where cables of different voltage are laid together at the same depth, vertical cable tiles shall be used to segregate the cables.

14. Control and communication cables shall be laid not closer than 300mm to any high voltage cables.
15. The Contractor shall carry out backfilling and shall ensure that cable cover tiles are undisturbed and that large rocks, stones and the like are eliminated from backfill spoil.
16. After backfilling the Contractor shall reinstate to finished ground level. The Contractor shall lay in position the necessary cable route markers at a maximum of 10 meters apart and at any change in direction.
17. The Contractor shall be solely responsible for ascertaining whether the soil is chemically active and for ensuring that the cables and accessories are suitable for the conditions prevailing on Site and for taking special precautions to protect the cables against chemical action.
18. A sufficient number of rollers shall be provided so that the cable does not touch the ground or twist during pulling.
19. All direct buried cables shall be provided with a sheathing material which shall not be degraded by the presence of salt or other minerals in the ground water in which they may be installed. The Contractor shall be responsible for determining the ground conditions for all externally installed cables.
20. Cables shall be installed in ducts where trenches pass under roads, paved area and foundations.
21. The open ends of all cable ducts (included unused ducts) and openings in building structures specifically provided for the passage of cables (including unused openings) shall be sealed after cable installation to prevent the ingress of harmful or flammable gases, liquid, smoke, fire and vermin.

END OF SECTON

SECTION 16300

WIRING DEVICES

PART 1 - GENERAL

1.1 VOLTAGE

All single phase devices shall be rated for 240/V 50 Hz and all three phase devices shall be rated for 415/V 50Hz.

1.2 DESCRIPTION

Provide wiring devices including switches receptacles, switch fuse units, junction boxes, control devices etc. as specified, indicated on drawings and as required for proper functioning.

1.3 RELATED WORKS SPECIFIED ELSEWHERE

A. Section 16120 Conduits

B. Section 16110 Raceways

C. Section 16200 Cables & Wire

1.4 REFERENCE STANDARDS

Lighting Switches	BS 3676 part 1/1989
Fuse Connecting unit	BS 1362
20A DP Switch	BS 3676 part1
Switch Socket Outlet	BS 1363/1984
Flux Outlets	BS 5733/1995
Dimmer light Switches	IEC 669-2-1,BSEN 50082-1
Cooker Control Unit	BS 4177/1992
Metal Clad Boxes	BS 5733
Weather Proof Socket outlets	BS 1363/1984
Sentry Socket outlet	BS 7288/199

Where No reference Standard is mentioned the applicable BS standard shall apply

PART 2 - PRODUCTS

2.1 SOCKETS

Sockets shall be 240V, three pin, and 13A switched type to BS 1363. Safety shutters shall cover pin holes to prevent accidental contact. Contact arrangement shall be such that contact is made on two sides of the rectangular pins of plugs.

UPS Socket outlets should be differentiated from the normal supply socket outlets.

Sockets shall be fixed inside galvanized stamped steel boxes or heavy gauge PVC type which shall be flush mounted in walls and fixed at 450mm above finishing floor level, unless otherwise indicated on the Drawings..
Pedestal mounted floor outlets shall be provided in locations where no wall or column is available
Sockets shall have white moulded cover plates as approved by the Engineer
Three phase sockets shall be of 5 pin design (3 phase + neutral + earth) as per the concerned local authorities Specifications. The current rating shall be as shown on drawings. All housing parts shall be pressure die cast in zinc base alloy and finished in hammered gray stove enamel; cable grips on the plugs shall have a rubber compression ring. The weather tightness shall be ensured by the rubber gaskets between plug and socket. Socket shall be provided with a screw-on cap. Plug top shall be provided with each socket.
Sockets working on normal plus emergency supply shall be provided with neon indicator which will remain illuminated even in off position.
13A weatherproof sockets outlets shall have the weather tightness as mentioned in paragraph `E' above and shall comply with the concerned local authorities Specifications.
Terminal shall be grouped in-line with terminal screws backed out and terminals shall be marked.
The wiring for the sockets shall be of high class, 4 mm2 stranded copper PVC insulated wires, embedded in PVC conduits.
Sockets may be 1 gang or 2 gangs, and protected by 16 amp MCB in the secondary distribution board. For water heaters and air condition units a double pole, 20 Amps switch with indication lamp shall be used, and protected by 20 Amp. MCB at distribution board.
All sockets outlets circuits shall be earthed by a special wire green or yellow and green different from the phase wire. The size of earth wire shall be same as the phase wire. The earth wire shall be taken from the distribution board.

2.2 JUNCTION BOXES

The junction boxes shall be DP 240V or TP 415 with current rating as shown on drawings or indicated in schedules. DP or TP switch controlling Junction Box shall be provided with neon lamp. Floor mounted J.B. shall be of water tight design as required by the particular equipment being fed through the J.B.

Indoor Wall mounted Junction box and its associated switch shall White molded & provided with flex outlet.

2.3 SWITCHES

Switches shall be of minimum 10A ratings unless higher ratings are shown on drawings.

Switches shall generally be flush mounted and of grid type at a height of 1300mm above finished floor level, unless otherwise indicated on the Drawings. Switches shall be White moulded cover plates as required by the engineer. Wiring terminals shall be of the screw type or solder-less pressure type having suitable conductor release arrangement. Where two or more switches are located in the same position, they shall be installed in one box and covered by a multi-gang cover plate. Weatherproof switches shall have weather tightness as per Clause 2.01 (F) above. Where Modular switches are employed the cover plate shall be manufactured in die cast metal with corners of square edged profile, and finished with a durable heat cured laccure. The Modular switches shall be 1– 8 gang as indicated in drawings.

2.4 DIMMER SWITCH FOR LED LAMP (IF NEEDED)

Remote control potentiometer unit shall be used for electronic dimmable LED driver shall be used. It shall have a rotary switch for 'ON\OFF' function and a control voltage range with "MAX" and "MIN" trimmings.

2.5 FUSED SWITCHED OUTLETS (IF NEEDED FOR ANY PARTICULAR EQUIPMENT)

These outlets shall be to BS 4662 and provided with fuse links to BS 646 or BS 1361 or BS 1362 complete as required.

2.6 MOUNTING BOXES

Mounting boxes shall be 1 gang or 2 gang as specified and shall be manufactured from hot dip galvanized steel. Each box shall have brass earth terminal fitted in base and shall include ample knockouts and adjustable lugs.

2.7 DOUBLE POLE SWITCHES

The double pole switches shall be with indication LED lamps and shall be rated 20 amps unless otherwise mentioned.

2.8 SPARKLESS SWITCHES and SOCKET OUTLETS

All switches and outlets shall conform to degree of protection as applicable to non-sparking equipment.

2.9 JUNCTION & SERVICE BOXES

The Junction & Floor Service boxes shall be supplied by the system supplier namely the Under Floor trunking or the Cast-in situ system as the case may be.

2.10 UPVC TRUNKING

Where Skirting & dado application are involved UPVC trunking of elegant profile shall be used. The system shall be capable of accepting wide range of components offering wide range of configurations. It shall be possible to use flat tees or angles & various type of adapters to navigate.

The trunking system shall be manufactured with requirements of BS 4678: Part 4 & BS 4662. Copies of test certificates shall be provided by the suppliers.

2.11 ISOLATORS AND SWITCH FUSES

Isolators and switch fuses, where mounted individually shall be of sheet steel/ Polycarbonate construction with /without doors and front operated handles. They shall be of the quick make, quick break type with removable shields over the fixed contacts, door interlocks and 'ON/OFF' indicators.

Isolators and switch fuses shall be single or triple pole with neutral, of ratings as indicated on the Drawings and provided with earth terminals. They shall be in accordance with IEC 408. The switch fuses shall be suitable for H.R.C. type fuses of Class Q1 to B.S. 88.

All outdoor isolators and switch fuses shall be in weather proof enclosures with IP-65 (unless otherwise indicated on the drawings).

2.12 Lighting Presence Sensor:

2.12.1. General

The purpose of using the lighting sensors:

Switch on the light source when the room is occupied.

Switch off the light sources or reduce the lighting to the minimum regulatory level when the room is not occupied.

2.12.2. Passive Infra-Red (PIR) Sensors:

For passageways (corridors, stairwells) where the activity of the occupants does not involve long periods of immobility (toilets, passages, mechanical areas, etc.), Passive Infra-Red (PIR) sensors must be provided (passive infrared technology incorporating a continuously operating light level measurement cell).

The detection range must provide full coverage of the passageway. When several sensors are needed, their detection areas must overlap. Minimum range up to 7m at 2.5m mounting height.

In areas with false ceilings, the sensors must be flush-mounted and be at least IP 20 and IK 04. Their consumption must not exceed 0.5 W when on standby.

Timer adjustment – continuous from 5 sec to 20 minutes.

In other areas, they must be surface or flush-mounted on the wall. Their consumption must not exceed 0.6 W when on standby.

The sensors must be used to control all types of load (Fluorescent, DALI, halogen, LED loads)

They must generally operate automatically, in walk-through mode:

If no movement is detected in the 3 minutes following an initial detection, the sensor must cut off the load without taking account of the set time delay

Otherwise, the device must cut off the load at the end of the set time delay the sensors can be connected to programme pushbuttons in some areas.

PART 3 - EXECUTION

3.1 MOUNTING HEIGHT

All devices shall be installed at levels as per the concerned local authorities' regulations.

Where Outlets feed particular piece of equipment then these shall be installed as per equipment manufacturer/supplier's requirements.

Where no data is available regarding the outlet for the equipment, it shall be installed at the level given by the engineer. As a guide line generally switches shall be mounted at 1300mm above finished floor level and sockets shall be fixed at 450mm above finished floor level unless otherwise required for specified uses e.g. Above bench or near the equipment etc.

3.2 FIXING

Fix outlet boxes securely

Fix exposed outlet boxes to permanent inserts or lead anchors with machine screws.

3.3 LIGHTING SWITCHES

Locate at the strike side of the door.

3.4 PULL BOXES /JUNCTION BOXES

Fix pull boxes at minimum 10 Meter spacing and to limit the number of bends in conduit to not more than two 90 deg. Bends

Locate junction boxes as inconspicuously as possible but accessible after work is completed.

END OF SECTION

SECTION 16400
DISTRIBUTION BOARDS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The work to be performed includes, but is not necessarily limited to, all work involved in the supply and installation of distribution boards as indicated on the drawings and as by the requirements of this Section.

B. The main distribution equipment shall comprise main low-tension distribution board, switching metering panels, sub-main distribution boards, distribution boards, Motor Control Centers, isolators, switch fuses ...etc. The supply and distribution arrangement shall be as indicated on schematic diagrams in the Drawings. The equipment shall be assembled and tested in the factory of approved panel builder/manufacturer. Where any equipment need to be assembled at site, a prior approval of the Engineer would be necessary.

C. Before placing any order for the supply of equipment, it shall be ensured that the physical sizes of equipment when installed shall not infringe any clearance required by the concerned local authorities' regulations. Where no such regulation is available, IEEE regulations shall be applied.

D. The types of distribution boards and accessories required for the Project include the following:

1. Final Distribution Board.
2. Sub main Distribution Board.
3. Main Distribution Board.

E. The contractual responsibility for the supply and installation shall be as indicated on drawings.

1.2 QUALITY ASSURANCE

A. The Contractor is responsible for the quality of all its purchased items and as such, must develop and submit a Supplier Quality Inspection plan for review. The inspection plan shall cover those items intended for shop inspection and the procedures for carrying out the same.

B. Manufacturer: Final, Sub main and Main Distribution boards shall be the standard products of a manufacturer regularly engaged in manufacture of such equipment and complying with the requirements of the listed standards and whose products have been in satisfactory use in similar service for not less than 5 years.

C. MDBs & SMDBs equipment shall be assembled and tested in the workshop of the approved local agent panel builder/ manufacturer. where any equipment need to be assembled at site, prior Engineers approval is required

D. Before placing any order for the supply of any MDB, SMDBs, it shall be insured that the physical sizes of equipment, when installed shall not infringe any clearance required by the concerned local authorities.

E. Codes and Standards: Comply with the requirements of latest edition of the following codes and standards except as herein modified.
1. BSI - British Standard Institution:

- BS 4293-Specification for residual current operated circuit breakers
- BS 5486-Low-voltage switchgear and control gear assemblies.
- BSEN 60439 Specification for low voltage switchgear and control gear assemblies.
- BSEN 60898 Specification for circuit breakers for over current protection for household and similar installation.
- BSEN 60947 Specification for low voltage switchgear and control gear.
- BSEN 61008 Residual current operated circuit breakers, without integral overcurrent protection for household and similar uses (RCCB's).
- BSEN 61009 Residual current operated circuit breakers with integral overcurrent protection for household and similar uses (RCBO's).

2. IEC - International Electrotechnical Commission.

- IEC 60439 Low voltage switchgear and control gear assemblies.
- IEC 60755 General requirements for residual current operated protection devices.
- IEC 60898 Electrical accessories circuit breaker for overcurrent protection for household and similar installations.
- IEC 60947 Low voltage switchgear and control gear.
- IEC 61008 Residual current operated circuit breakers without integral overcurrent protection for household and similar uses (RCCB's)
- IEC 61009 Residual current operated circuit breaker with integral overcurrent protection for household and similar uses (RCBO's).
- Distribution boards and Motor Control Centers shall comply with the following as appropriate. Where no regulation / standards are mentioned latest IEC standards shall be applicable.

BS 88	Cartridge Fuses
BS142 (Latest)	Electrical Protective Relays
BS 159	Busbar & Connections
BS 162	Electrical Power Switchgear
BS 3938 IEC 185	Current Transformers
BS 4794 IEC 337-2	Control Devices
BS 5685	Electricity Meters General
BS 89 IEC 51 Inst.	Direct Acting Indicating Electrical Measuring
BS 5685 IEC 521	Electric Meters
BS 5420 IEC 144	Degree of Protection of enclosures
BS 4752 IEC 947-2	Switchgear & Control Gear
IEC 947-4	Contactors
IEC 947 (Part 1-7)	Low Voltage Switchgear & Control Gear
IEC 439 (Part 1-4) assemblies	Low voltage Switchgear & Control gear

1.3 TESTS AND ACCEPTANCE CRITERIA

Material Test: Unless requirement is waived in writing, submit to the Engineer two copies of manufacturer's test reports certifying that materials meet specified standards.

1.4 SUBMITTALS

The Contractors shall submit to the Engineer in accordance with the provisions of Section, the required documents to establish compliance with this section. Submittals shall at least include the following:

1. Manufacturer’s data including specifications, installation instructions and general recommendations for each type of distribution board required. Include data substantiating that units comply with requirements.

Shop drawings single line diagram, schedule of points and dimensioned drawings of distribution boards and enclosures showing accurately scaled layouts of enclosures and required individual board devices, including but not necessarily limited to circuit breakers, residual current circuit breaker, disconnector.
Test certificates.

PART 2 - PRODUCTS

2.1 DISTRIBUTION BOARDS - GENERAL

2.1.1MAIN AND SUB MAIN DISTRIBUTION BOARDS

Distribution boards shall be of the totally enclosed metal clad pattern manufactured to IEC 60439/BS 5486 standards unless otherwise specified.
Each distribution board shall be arranged for top and bottom cable entry and shall be provided with an ample cable termination plate and chamber to enable cables to be neatly gladded with tails grouped and terminated onto appropriate internal terminations. Distribution boards shall be wall or floor mounted and shall when specified incorporate on-load isolators which shall be front of panel operated with ON/OFF indicator and capable of being padlocked in the OFF position. Distribution boards shall incorporate combination of single pole and triple pole circuit breakers shown on the drawings.

The termination of the circuit cables at distribution boards shall be neat and slack left at each circuit breaker or neutral bar to enable the complete assembly to be removed for inspection without disconnection. Neutral conductors shall be connected to the bar in the same order as the phase conductor to the circuit breaker.

Each distribution board shall be complete with a permanent circuit identification chart preferably counted within the front door. This chart shall be permanently and legibly filled in as circuits are complete with the circuit description including the breaker rating.

Painting of distribution boards shall be in approved colors.

The boards shall be properly earthed by connecting an earthing conductor from main distribution earth bar to an earth connector welded to the cabinet.

The main and sub main distribution board will be supplied, installed and tested at the electrical rooms of the buildings.
The main and sub-main distribution boards shall be totally enclosed, dust protected and factory fabricated suitable for operation on 415/240 V, 3-phase, 4-wire, 50 Hz supply.
Main and sub-main distribution boards shall comprise main incoming breakers, bus bars, Air or molded case circuit breakers, earth leakage relays, earth bus, etc. with ratings and arrangement as shown on the Drawings and all housed in a sheet steel panel fully rust-proofed and electro-static powder coated paint; equipped with a hinder door with approved locking device.
The Main and Sub-main Distribution Boards shall be metal enclosed self-supporting structure independent of wall supports. They shall be free standing, dust and vermin protected, the sides and rear shall be covered with removable screw-on plates
Main and Sub-main Distribution Boards shall be assembled according to IEC 439 or BSEN 60439 standard and shall be three-phase with earth and neutral.
Doors, covers and sides are to be made from galvanized sheet metal at least 2 mm thick, painted with two primary coats and two final coats of gray oil paint. The cabinets are to be designed for placing against the wall. Doors must strike in the direction of escape routes and are to complete with locks for double bit keys and central locking system. To avoid earthing problems, internal parts may not be varnished. Doors are locked with double bit keys.
The Distribution Boards shall consist of the required number of vertical sections bolted together to form one rigid distribution board. All edges of front cover panels shall be formed.
All doors and removable cover plates, shall be provided with neoprene gasket to obtain degree of protection IP54 to IEC 144. The steel enclosure shall be protected to IP 54.

2.1.2 FINAL DISTRIBUTION BOARDS

The arrangement of the enclosure shall be such that the switch, MCB, RCCB and RCBO cannot be operated without opening the hinged doors. To obtain access to MCB, RCCB and RCBO it should be necessary to remove the fixed cover.
For final distribution board, miniature circuit breakers may be used, unless otherwise specified.

The final distribution boards shall be controlled by an adequately rated ON load disconnect or to interrupt the supply to the entire distribution board unless otherwise indicated on the drawings.

The arrangement of the MCB in the triple pole distribution board shall allow replacing a triple pole MCB with three adjacent single pole MCB's and vice versa. The directory of the circuit to be kept in a plastic pouch affixed to the inside of the hinged door.

It should be possible to install RCCB or RCBO for each branch.

Distribution boards shall be single phase and neutral or three phase and neutral. Neutral connections shall be provided in number equal to the number of single-phase ways.

Distribution boards shall be of the fully shrouded pattern to prevent accidental contact with live parts.

Distribution boards employing miniature circuit breakers shall be capable of accepting breakers of mixed ratings and of standard or residual current detection type.

Distribution boards shall be provided with an earth bar to allow connection of circuit protective conductors. The number of connections shall be equal to the number of single-phase ways. A main earth terminal shall be provided to allow bonding of the enclosure in accordance with the requirements of the listed Standards.

Such an earth terminal shall also be provided on the local disconnector enclosure where this forms a separate unit to the distribution board.

2.2 BUSBARS

The distribution board shall be provided with fully rated Bus bars for the entire width of the board. In addition, each section or panel of the distribution board shall be provided with vertical bus bars of adequate rating to provide branch connections to the outgoing breakers.

The horizontal and vertical busbars and connection shall be fully segregated such that these shall not be accessible when the compartment doors and cable way covers are opened. They shall be provided with barriers which be removable by tool or special key.

The busbars shall be made of electrolytic, hard drawn high conductivity flat pure tinned copper bars complying with IEC Standard. The whole busbar system shall comply fully with the requirement of latest IEC standards.

The busbars shall be of sufficient size to limit the temperature rise above ambient temperature and rated to withstand mechanical forces exerted during short circuit conditions when directly connected to a power source having an available fault current as estimated at rated voltages.
Busbar system shall provide 3 phases + neutral + earth with colors Red, Yellow, Blue for the three phases, Black for Neutral and Green for Earth. Type testing reports about the installed busbar system must be submitted to the Engineer.

The busbars shall be air insulated and shall be rigidly supported on purpose made insulators of non-hygroscopic glass fiber moldings having a tracking index of not less than 600.

The Main Low Tension Panels bus bar together with its connections to the incoming and outgoing unit shall be suitable to withstand a short circuit of 50,000 sym. amperes and in all other cases, it shall be suitable for the fault level at that point.

The busbars shall be provided with colored PVC at regular intervals for phase identification. Painted busbars may be acceptable in exceptional cases when panels are manufactured / assembled in Jordan.

2.3 CURRENT TRANSFORMERS

Current transformers are to be supplied insulated in resin with either a wound core or a pushing bar with one or two cores, with performances and precision classes.
Current transformers shall be of Class C accuracy for indication and Class CM accuracy for metering purpose. The secondary windings shall be rated at 5A and the rated output shall be suitable for the burden.
Current transformers shall be designed as plug-on transformers through which both busbars and wires can be routed. The power rating shall be established in accordance with the instruments and devices to be connected, the minimum power rating being 10 VA. The precision class shall be determined to be 1.

2.4 INSTRUMENTS

The measuring instruments shall include ammeter voltmeters, maximum demand indicators and selector switches as indicated on the Drawings.

The instruments shall have anti-glare glass fronts, anti-parallax scales and white faces with black numerals and markings. The instrument cases shall be semi-flush mounted and shall be approximately 100 x 100mm square. Accuracy shall be one percent of full scale values. Moving elements shall be provided with zero adjustments external to the cases.

The degree of protection is to be IP 54, the accuracy class at least 1.5. Each normal position of used has to be applicable for the location in which it is installed and the replaceable quadrant scale is to be appropriate for the item measured. The instruments shall not allow the possibility of an operator touching live electrical parts.
Ammeters shall be moving iron type, to B.S. 89 scaled 0-2000 A for main incoming supply.
Voltmeter shall be moving iron type to B.S. 89 scaled 0-500V and provided with 6-position selector switches allowing reading of line to line and line to neutral voltages.
Maximum demand indicators shall be of the thermal type with a 15-minute time delay.

PART 3 - EXECUTION

3.01 INSPECTION

The Contractor must examine substrates and conditions under which work will be done and correct any unsatisfactory conditions. Do not proceed with work until all unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

3.02 INSTALLATION

A. In addition to the instructions contained herein, manufacturer's drawings and instruction books for the equipment and material to be installed here under must be followed explicitly except where manufacturer's instructions differ from these technical specifications.

B. Check foundations, wall thicknesses and structural elements upon which equipment and materials shall be mounted to verify that there are no errors or omissions in locations or in position of anchor bolts. Any errors or omissions which may be disclosed by this inspection must be reported to the Engineer without delay.

C. All devices and equipment mounted within the distribution boards and which require earthing shall have their conductive non-current carrying parts effectively bonded to cabinet. Earth bar to be mounted near base of cabinet for connection of equipment earthing conductors.

D. Do not remove, alter, drill, load or connect to structures, except where required for by drawings or approved by the Engineer.

E. Protect and maintain equipment and materials from time of delivery until accepted for operation by Engineer. This period includes, but is not limited to, storage prior to installation, erection phase, lay-up prior to operations, and preliminary operation.

F. Store material and equipment off ground or floor.

G. Provide services for certain equipment such as space heaters, electrical testing, and maintenance of protective covers and coatings as required by manufacturer.

H. Prior to acceptance of installation correct all damage and corrosion occurring after delivery.

I. Use proper and adequate handling equipment and rigging at all times. Examine equipment and rigging and check at frequent intervals.

J. Install distribution boards and enclosures where indicated, in accordance with manufacturer's written instructions, applicable requirements of listed standards, and in compliance with recognized industry practices to ensure that products fulfill requirements.

K. Coordinate installation of distribution boards and enclosures with cable and raceway installation work.

L. Anchor enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secure.

M. Provide electrical connections within enclosures.

N. Fill out distribution boards' circuit directory card upon completion of installation work.

O. Distribution boards shall be mounted with their center lines approximately 1700 mm above the finished floor, except that the highest breaker shall in no case be more than 2000 mm above the finished floor.

P. Board directory, as a minimum, shall indicate breaker position number, equipment served, room name and number.

Q. All conductors shall have label tags affixed prior to trim installation.

R. All breaker positions shall be numbered.

S. All breaker trip ratings shall be readable without removing panel front cover.

3.03 CIRCUITS AND CONNECTIONS

A. Provide all outgoing circuits with separate compartment and/or screen so that equipment for any one circuit can be maintained without risk of contact with line connections on any other circuit.

B. Connect feeders, for circuits rated up to 63A, to terminal blocks located in separated compartments at top or bottom, conveniently arranged to facilitate termination of cables and suitably identified.

C. For feeders, rated more than 63A, suitably extend copper links rigidly supported and covered with colored PVC sleeves.

D. Provide all feeders with cable lugs and brass cable glands.

E. Provide removable gland plates suitable for the glands required for the specified cables. Where cables are single core, the gland plates shall be of a non-ferrous metal.

F. Provide all small wiring of stranded copper, not less than 2.5mm2 with PVC insulation to B.S. 6231. Small wiring shall be neatly bunched and cleat in

G. Harness form, or shall be enclosed in purpose made plastic trunking. Wiring cleat to metal surfaces shall be insulated from the metal. Where wiring runs through sheet steel panels, holes shall be grommet with suitable grommets.

H. Connect small wiring associated with external circuits to terminal strips conveniently arranged.

I. Provide each connection with separate incoming and outgoing terminals with no more than two wires to be connected to any terminal.

J. Wire all spare contacts to terminal strips suitably positioned.

K. Identify all wiring using plastic ferrules at both ends

END OF SECTION

SECTION 16500
LIGHTING SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION
The work to be performed includes, but is not necessarily limited to supply, installation, Connection and testing of all the interior lighting system.

1.02 SCOPE OF WORK
Supply all labor, tools, services and equipment and provide all the materials required to Complete this section of the work.
The lighting installation for this project shall consist of the following systems but shall not be limited to eternal lighting fixture.

1.03 QUALITY ASSURANCE
A. **Manufacturer:** The components of the interior building lighting shall be the standard Products of a manufacturer regularly engaged in manufacture of such components of types and sizes required and complying with the requirements of the listed standards and whose products have been in satisfactory use in similar service for not less than 10 years.

B. **The Contractor:** is responsible for the quality of all its purchased items and as such, must develop and submit a Supplier Quality Inspection Plan for review by the Engineer.
The inspection plan shall cover those items intended for shop inspection and the procedures for carrying out the same.

1.04 TESTS AND ACCEPTANCE CRITERIA
Material Test: Unless requirement is waived, materials shall be tested and manufacturer's Test reports certifying that materials meet the requirements of the listed standards shall be submitted.

1.05 SUBMITTALS
A. The Contractor shall submit to the Engineer the following:
Manufacturer's Data: Submit following manufacturer's data:

1. Full detailed technical Manufacturer Catalogues (data sheets) showing the type of the fitting proposed, photometric data, rated voltage, and maximum Working temperature, type and size of internal wiring and full detailed technical specifications which must be confirmed by the website of the manufacturer.
2. Full technical details of the driver including manufacturer, type of insulating material, maximum temperature rise.
3. Full technical details of the power factor correction capacitor, including manufacturer, voltage, frequency, capacitance, number, integral discharge resistor etc.
4. Sample of each of the proposed lighting fitting to be submitted.

B. Shop Drawings: Including dimensioned drawings of each luminaire dimensioned reflected ceiling lighting layout.

PART 2 – PRODUCTS

Standards

IEC Standards

BS Standards

Products must comply with at least three of : **CE, TUV, ROHS**,(LM79, LM80 LM70,EN and UL) or equivalent test standard:
The supplier must submit to the engineer the (**LM79, LM80 AND LM70)** test reports done by the manufacturer or authorized third party.

2.01 GENERAL

The types of luminaires for interior lighting required is LED luminaries and the applications of luminaires for interior lighting shall include the following:

A. **Emergency lights:**

Self-contained emergency lights, suitable for use on 240 volts, 50 Hz current and shall consist of:
Battery with a capacity of at least 3 hours for operation in case of power failure

Automatically controlled, solid-state, two-rate charger.

A transfer relay.

Switch for controlling the LED Chip circuit.

Signals to indicate when the LED Chip circuit is in position to provide emergency protection, and to indicate high-charge rate.
Test switch for testing the Light and battery.

(1W) LED lighting fixture.

Appropriate indication and arrow or exit lights.

Nickel cadmium battery.

B. **General lighting:**

Luminaires shall be completely self-contained, unless otherwise specified, and include all control switch, reflectors, and diffusers, as required.
All Luminaires shall be completely including all control switch, reflectors, and diffusers, as required & must be **full- package assembled in the manufacturer factory.**
Luminaires shall be recessed, surface-mounted, suspended.

The lighting fixture must be LED panels.

SMD and or COB chips are accepted only.

2.02 Construction, Wiring, supplying source and protection:

A. Luminaires shall be of the type, size and rating indicated on the drawings, complete with, but not necessarily limited to, built-in LED Chip, reflectors, diffusers, baffles, control gear and wiring to form a complete unit to allow the luminaire to function and produce the photometric performance in accordance with manufacturers published data and/or that specified herein.

B. Luminaires shall be suitable for trouble free use on 240 Volts, 50 Hertz.

C. Each luminaire shall be protected against environmental conditions in which the luminaire will be installed and shall comply with individual specification of each type of luminaire described.

D. Wiring: Within the luminaire, the wiring shall not be less than 1.0 mm².

E. Insulation within luminaires shall be silicone rubber for the lower temperatures (led luminaires) and shall be thermal resistance flame retardant for the higher temperature.

F. Sheet steel housings used in luminaires shall not be less than 0.7 mm or heavier when required. Sheet steel reflectors shall have a thickness of not less than 0.8 mm. Aluminum reflectors shall have a thickness of not less than 1 mm.

G. All metal works shall be mitered, welded and smoothed. The metal parts of the luminaire shall be completely free from burrs and tool marks. Solder shall not be used in any part of the luminaire for jointing.

H. Ferrous metal sheets shall be galvanized, copper plated, given a corrosion-resistant phosphate treatment or other approved rust-inhibiting prime coat, to provide a rustproof base before application of finish.

I. Luminaires with visible frames shall have concealed hinges and catches. Hinged diffuser doors shall be provided with stainless steel clips or equal retaining devices of non-corroding materials.

J. Recessed luminaires shall be constructed so that control gear is replaceable without removing housing from ceiling.

K. All luminaires shall be capable of operating continuously in the ambient Conditions specified.

L. Any reduction in performance due to abnormal ambient or operating conditions shall be notified at the time of submittal.

M. All luminaires shall be suitable for mounting on or suspension from a conduit box or mounting to a flat surface and shall be complete with conduit or glanded cable entry facility.

N. All luminaires shall be complete with all necessary LED Chip control gear, reflectors, diffusers, baffles or visors to form a complete unit to allow the luminaire to function and produce the photometric performance, in accordance with manufacturers published data and/or that specified herein.

2.03 LED LIGHTING PANELS

Supply, install & connect of the following (led-panel) lighting fixtures including the panel itself with 50000h or Above life time as specified Below, drivers or chips (Tridonic, Philips, TCI, HEP, helvar, OSRAM, Cree, or the approved by the manufacturer) or control gear where required with all material & work & handing over completely clean, tested & in operable condition.
(All lighting fixtures, led and control gear or d rivers must be full-package from approved manufacturer)

1) **LF1 (TYPE A & B):**
Recessed 60x60 (led-panel) lighting fixture 30-40W, back lit type, 4000K color temperature, output **125 lm/w**, UGR<19 compliant with EN12464, opal or soft micro prismatic diffuser, power factor > 0.95, Color Rendering Index CRI ≥ 90, color tolerance ≤3 Mac Adam step (SDCM), Lifetime: **70000 hours** @ L80B20, Energy Class A+, complete back lit type aluminum housing, IP40, RG0 or RG1 Eye safety, **CE / EN 62471 / EN 60598 STANDARD**

2) **LF2:**
Surface mounted (125cm±x23cm±) (LED-panel) lighting fixture 50± W, 4000k,5000 or 5700 color temperature , output **125 lm/w** ,UGR<22 compliant with EN12464 ,opal or soft micro prismatic diffuser ,power factor>0.95 , Color Rendering Index CRI ≥ 80, color tolerance ≤3 Mac Adam step (SDCM), lifetime: **70000 @ L80B20** ,energy class A+, polycarbonate housing, weatherproof IP65, IK10, Built-in driver.

3) **LF3:**
Recessed down light Ø170-250± mm lighting fixture 22-32W, 4000K color temperature, output **100 lm/w**, UGR<22 compliant with EN12464, opal polycarbonate diffuser, power factor > 0.95, Color Rendering Index CRI ≥ 80, color tolerance ≤3 Mac Adam step (SDCM), Lifetime: **50000 @ L80**, Energy Class A+, Polycarbonate body or Die-cast aluminum body housing, IP20, RG0 or RG1 Eye safety.
CE / EN 62471 / EN 60598.

4) **LF4:**
Recessed down light Ø170-250 mm lighting fixture 22-32W, 4000K color temperature, output **100 lm/w**, UGR<22 compliant with EN12464, opal polycarbonate diffuser, power factor > 0.95, Color Rendering Index CRI ≥ 80, color tolerance ≤3 Mac Adam step (SDCM), Lifetime: **50000 @ L80**, Energy Class A+, Polycarbonate body or Die-cast aluminum body housing, **IP44**, RG0 or RG1 Eye safety.
CE / EN 62471 / EN 60598.

5) **LF5:**
Surface Mounted Ø270-400± mm lighting fixture 24-34W, 4000K color temperature, output **100 lm/w**, UGR<22 compliant with EN12464, opal polycarbonate diffuser, power factor > 0.95, Color Rendering Index CRI ≥ 80, color tolerance ≤3 Mac Adam step (SDCM), Lifetime: **50000 @ L80**, Energy Class A+, Polycarbonate body or Die-cast aluminum body or epoxy powder coating body housing, IP54, RG0 or RG1 Eye safety, Built-in driver.
CE / EN 62471 / EN 60598.

6) **LF6:**
LED wall Mounted Ø270-400± mm lighting fixture Bulkhead with stainless steel mesh guard, 24-34W, 4000K color temperature, output **100 lm/w**, opal polycarbonate diffuser, power factor > 0.95, Color Rendering Index CRI ≥ 80, color tolerance ≤3 Mac Adam step (SDCM), Lifetime: **50000 @ L80**, Energy Class A+, Polycarbonate body or Die-cast aluminum body or epoxy powder coating body housing, IP65, IK08, RG0 or RG1 Eye safety, Built-in driver.
CE / EN 62471 / EN 60598.

7) **LF7:**
Recessed down light Ø 70-90± mm lighting fixture (7 – 10) W, 4000K color temperature, output **75 lm/w**, UGR<22 compliant with EN12464, opal polycarbonate diffuser, power factor > 0.95, Color Rendering Ra ≥ 80, color tolerance ≤3 Mac Adam step (SDCM), Lifetime: **50000 @ L80**, Energy Class A+, Polycarbonate body or Die-cast aluminum body or epoxy powder coating body housing, heat sink, **IP20**, RG0 or RG1 Eye safety.
CE / EN 62471 / EN 60598.

8) **LF8:**
wall Mounted 550-600 mm mirror led lighting fixture 10-15W, 4000K color temperature, output **100 lm/w**, weather proof clear diffuser, power factor > 0.95, Color Rendering Ra ≥ 80, color tolerance ≤3 Mac Adam step, Lifetime: **50000 @ L80,** Energy Class A+, Polycarbonate body or Die-cast aluminum body or epoxy powder coating body housing, (Corrosion, Water) IP44, RG0 or RG1 Eye safety, Built-in driver.
CE / EN 62471 / EN 60598.

9) **LF9:**
Floodlight, 80W, 5700K color temperature, output **125 lm/w**, clear glass diffuser, power factor > 0.95, Color Rendering Ra ≥ 80, color tolerance ≤3 Mac Adam step (SDCM), Lifetime: **50000 @ L80**, Energy Class A+, High corrosion resistance die-cast aluminum body and bracket, Polyester painting with phosphor-cremating pre-finish clear glass diffuser, black color, wide beam angle, IP65, IK08, Built-in driver.
CE / EN 62471 / EN 60598.

10) **LF10:**
LED-Square wall-recessed or Simi-recessed luminaire for outdoor 250-100± mm lighting fixture, (8-10) W, output **75 lm/w**, High corrosion resistance die-cast copper-free aluminum body, IP65, IK08, Tempered Glass, 4000K, Lifetime: **50000 @ L80.**

11) **LF11:**
15-25w, 4000K, IP65, IK10, 750 lm, round shape, for outdoor surface installation, 360º light emission, phosphor - achromatized and polyester powder coated die-cast copper-free aluminum body, polycarbonate diffuser, molded silicone gasket and stainless-steel screws, Anchorage bolts included, Built-in LED driver 220-240V 50-60Hz, Lifetime: **50000 @ L80**.

12) **LF12:**
12W, 3000K, IP65, IK07, 720LM, cylindrical/square shape up & down, for outdoor wall installation, powder coated die-cast copper-free aluminum body, polycarbonate diffuser, moulded silicone gasket and stainless-steel screws, Anchorage bolts included, Built-in LED driver 220-240V 50-60Hz, Lifetime: 50000 @ L70.

13) **LF13:**

4W, 240LM, narrow beam (30-40) degree, outdoor recessed down light ø 70-90 mm lighting fixture, 3000k color temperature, toughened transparent with asymmetric reflector, color tolerance ≤3 Mac Adam step, lifetime: 50000 @ L80, die-cast aluminum body with heat sink, IK08, IP65.

14) **Exit Signs:**
3w, wall/ceiling exit blade maintained, one or two sided with suitable signs & leaders (in English and Arabic languages) as shown in drawings, visible from a distance of 25m, suitable for use as maintained and non-maintained, color rendering ra≥80, NICAD battery, recharge time 24 hrs., work for 3 hrs., lifetime: 50000 @ l80.**BS EN60598-2-22 / EN 1838**.

15) **Motion Detector:**
360° motion sensor , IP44, minimum 8m range, flush ceiling mounting, 3-wire with neutral, Light level threshold: 10 to 2000 lux, Manual adjustment of light level threshold and time delay via potentiometer, Adjustable time delay: 10 s to 10 min.

16) **Presence Detector:**
360° passive infrared and ultrasound presence sensor IP44, minimum 8m range, flush ceiling or surface mounting, 3-wire with neutral, Adjustable time delay: 10 s to 10 min.

17) **Presence Detector:**
360° passive infrared and ultrasound presence sensor IP20, minimum 20m range, flush ceiling or surface mounting for corridor, 3-wire with neutral, Adjustable time delay: 10 s to 10 min.

2.04 MAINTENANCE AND WARRANTY

For a period of 24 months labor and parts following date when completed and placed in operation, provide full maintenance of Correct operational faults, and restore/replace defective/deteriorated components and finishes and supply materials as required for proper operations and maintenance.

2.05 APPROAVED LIGHTING FIXTURE MANUFACTURER

ALL LED LIGHTING FIXTURES MUST BE SUPPLIED BY ALOCAL DISTRIBUTOR OR AGENT ESPECIALIEST IN LED LIGHTING.

END OF SECTION

SECTION 16611
UNINTERRUPTIBLE POWER SUPPLIES (UPS)

PART 1 – GENERAL

1.01 DESCRIPTION

A. The work to be performed includes, but is not limited to all work involved in the supply, installation, connection and testing of the UPS systems

B. All UPS supplied shall be suitable for the power supply of critical area and information technology equipment.

1.02 QUALITY ASSURANCE

A. The Contractor is responsible for the quality of all purchased items and as such, must develop and submit a quality inspection program for review. The inspection plan shall cover those items intended for shop inspection, field supervision and the procedures for carrying out same.

B. The UPS shall be the standard products of a manufacturer regularly engaged in the manufacture of UPS of types and ratings required and complying with requirements of the listed standards and whose products have been in satisfactory use in similar service for not less than 5 years.

C. Applicable Codes and Standards: Comply with the requirements of the following codes and standards except as herein modified:

1. BSI-British Standard Institution:
   - BS 6290 Nickel cadmium stationary cells and batteries
   - BSEN 50091- Specification for uninterruptible power supply
   - (UPS)
   - BSEN 55011- Specification for limits and methods of Measurement of radio-disturbance characteristics of industrial, scientific, and medical (ISM) radio frequency
   - BSEN 60146-1-1- Semiconductor convertors. General requirements and line commutated convertors.
   - BSEN 60950 Specification for safety for information technology equipment including electrical business equipment.
   - BSEN 61000 Electromagnetic compatibility (EMC).
2. IEC International Electro Technical Commission.
   - IEC 61014-4- Semiconductor convertors - Method of Specifying the performance and test requirements of uninterruptible power systems.
   - IEC 60146-5- Semiconductor convertors - Switched for uninterruptible power systems.
   - IEC 60801 - Electromagnetic compatibility for industrial process measurement and control equipment.
   - IEC 61000 - Electromagnetic compatibility.
   - IEC 620040-3 - UPS Topologies and standards.

1.03 TESTS AND ACCEPTANCE CRITERIA

A. Factory tests shall be given in accordance with relevant standards.

B. The Contractor shall perform site acceptance test to ensure that the entire system is in proper working order and each piece of equipment will perform its functions in the manner intended.

1.04 SUBMITTALS

A. The Contractor shall submit to the Engineer to comply with this section:

1. Shop Drawings: Indicate electrical characteristics and connection requirements.
2. Provide battery rack dimensions: battery type, size, dimensions, and; detailed equipment outlines location of conduit entry and exit; single-line diagram indicating metering, control, and external wiring requirements; heat refection and air flow requirements.
3. Product Data: Provide catalogue sheets and technical data sheets to indicate physical data and electrical performance, electrical characteristics, and connection requirements.
4. Manufacturer's Installation Instructions: indicate application conditions and limitation of use stipulated by product testing agency. Include instruction for storage, handling, protection, examination, preparation, installation, and starting of product. Include equipment installation outline, connection diagram for external cabling, internal wiring diagram, and written instructions for installation.
5. Manufacturer's certificate: Certify that products meet or exceed specified requirements.

PART 2 – PRODUCTS

2.01 UPS CONFIGURATIONS

A The topology of the UPS shall be of the double conversion type as designated in IEC 62040-3.

B In this type, the inverter is connected in series between the AC input and the load with power for the load flowing continuously through the inverter.

2.02 UPS COMPONENTS

A. The various components of the UPS are the following:

1. Batteries
2. Rectifier/ charger to maintain battery charge and to provide input to inverter when utility power is not available.
3. Inverter to provide power to load during normal operation.
4. Static switch to transfer load automatically and without disturbance between inverter and utility power.
5. Manual switch to bypass static switch for maintenance.
6. Input and output **isolation transformers** and filters to provide appropriate isolation and disturbance attenuation.

7. Monitors, sensors, and control circuits.
8. Testing the full load using **dummy load** to be available on site on contactor responsibility.
9. UPS Network Management Card with Environmental Monitoring Requirements.

2.03 OPERATIONS-GENERAL

The UPS shall operate in the following three operation **modes**: normal, stored - energy, and by pass.

A **Normal Mode**

The load is continuously supplied via the rectifier/charger/ inverter combination which carried out a double conversion (AC - DC - AC).

B Stored Energy Mode

When the AC input supply voltage fails or goes outside the UPS's pre-set tolerance, the inverter and battery continue to support load power. The UPS runs in stored – energy Mode for the duration of the stored energy time, or until the AC - input supply returns to within the pre-set tolerances, at which point the UPS returns to normal mode.

C Bypass Mode

1. The UPS shall be equipped with a static bypass allowing the instantaneous transfer of the load to the bypass AC input. This facility is used in the event of a UPS internal malfunction, load current transients, overloads or at the end of the battery, backup time. The UPS shall be synchronized with the source of the bypass AC supply to ensure transfer of the load without a break in power.

2. A maintenance bypass, consisting of a manual switch shall be provided.

2.04 CONSTRUCTION

A. The UPS shall be free-standing with removable panel constructed from zinc coated sheet steel.
B. The enclosure shall have an IP rating of IP21.
C. The UPS shall be arranged such that the cable entry positions are either through the rear or bottom of the UPS.

D. The air inlet shall be equipped with permanent type filters and the cabinet shall be pressurized otherwise gasket shall be provided around door and panel openings to prevent entry of dirt.
E. The cabinets shall be primed and painted inside and outside with suitable semi-gloss enamel.
F. UPS systems shall be of different rates as shown in the bill of quantities

- As per B O Q () KVA– 415/230V- 50Hz

2.05BATTERY SUPPLY

A. The UPS shall have a battery supply in an independent cabinet or enclosure manufactured to match the UPS module.
B. The battery cabinet shall be supplied complete with isolation fuse / breaker and associated wiring to connect to the UPS.
C. The batteries to be tested must be the sealed led acid gel batteries maintenance free type manufactured in accordance with BS.
D. The autonomy time of the battery cabinet shall be 10 minutes' minimum.
E. The electrolytic specific gravity shall not be greater than 1.250 when full charged and measured at 25ºC.
F. The ampere hour rating shall be sufficient to supply direct current to inverter for outage period specified with inverter operating at 80% output to a discharge limit of not less than 1.2 V per cell.
G. The batteries shall be cabinet mounted.
H. **The batteries shall be sealed led acid gel, with 8 years' life time**
I. **BATTERIES MUST be manufactured not more than 8-months before installation and put to operation.**

2.06DESIGN

A. Inverter shall be of pulse-width cabinet type

B. Rectifier / Charger Capacity shall be sufficient to supply full load to inverter while recharged in fully discharged battery to 95 percent of full capacity in eight hours or less; and within the input current limits specified.

C. Means shall be provided for on-line testing of UPS, including test points to allow adjusting and servicing and for testing, static switch while load is bypassed to utility.

E. Forced convection or natural convection cooling shall be provided as recommended by manufacturer. Where specified, provide forced air cooled unit with redundant cooling so that failure of any one cabinet cooling fan or fan circuit will not affect continued operation at full load and ambient temperature of 40 degrees C or lower.

2.07GENERAL CHARACTERISITICS

A. Operational Characteristics.

Input Characteristics

Voltage - Three Phase 415V
Voltage Tolerance - 415V ± 15%
Frequency - 50 Hz ± 5%
Power Factor - 0.94 with filter

Output Characteristics

Voltage	: 415V 3Ph + Neutral
Voltage Stability	
- Steady state	:< ± 1%
- 100% load step	:< ± 5%
Frequency synchronized with the	
Bypass supply	: ± 1 Hz
Auto-synchronized	: ± 0.1 Hz
Battery Recharge Time	: 8 hours to 90%

Where the UPS load requires more stringent power supply characteristics than are outlined above, the power supply characteristic requirements of the load equipment as specified by the load equipment manufacturers shall be used in preference to the characteristics outlined above.

2.08 CONTROLS AND MONITORINGS

A Controls:

1. The UPS shall be controlled using microprocessor based technology.
2. The following controls must be provided:
   a. A C input circuit breaker.
   b. “ Inverter operates" switch to initiate inverter operation.
   c. “ Inverter standby" switch to cause inverter to cease operation.
   d. “ Static switch transfer" switches to permit manual actuation of static transfer switch.
   e. “ Static switch lock-out" switch to inhibit automatic retransfer of load to inverter. f.Battery charge timer.
   f. "Indicator test" switch.
   g. Static switch preferred input circuit breaker.
   h. Static switch output circuit breaker.
   i. Static switch bypass circuit breaker.
   j. Controls for maintenance bypass switch

B The UPS shall have the following LED to indicate its status.

1. "Utility power available"
2. "Utility bypass power available"
3. "Inverter output available"
4. "Load connected to inverter output"
5. "Inverter synchronized to utility"
6. "Load connected to utility"
7. "Static transfer switch inhibited"
8. "High/low DC voltage"
9. "Over temperature"
10. "Inverter output overload"
11. Rectifier on
12. Inverter on

C. Meters; 1 percent accuracy meters shall be provided to indicate the following:

1. Rectifier / charged DC voltage and current
2. Utility, inverter output, and load AC voltage.
3. Load AC current
4. Inverter output and utility frequency
5. UPS output watts

Digital meters and screen keyboard are acceptable

D. Alarm Panel: Flush mounted, annunciator panel with monitoring and alarm functions.

1. "High/low DC voltage (alarm)."
2. "Over temperature (alarm)"
3. "Inverter output overload (alarm)"
4. Audible alarm (sounds when nay of the above alarm con.)
5. Alarm / indicator "silence / test" switch

2.10.MAINTENANCE AND WARRANTY

Maintenance: For a period of **24** months following date when the system is completed, placed in operation, & accepted by the engineer provide full free maintenance of the system including the batteries a monthly-surveillance basis. Correct operational faults and restore/replace defective/deteriorated components and finishes. The price includes a two-year free maintenance written contract with the local agent supplier labor and parts, back to back through the contractor.

PART 3 – EXECUTION

3.01 INSPECTION

A The Contractor must examine all site conditions under which work will be carried out and correct unsatisfactory conditions. Do not proceed with work until all unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

3.02 INSTALLATION

A Installation shall be in accordance with manufacturer's instructions. It shall also be in Accordance with relevant parts of other sections of this specification.

B The UPSs shall be properly earthed by connecting an earth rod in the ground to the main Earthling terminal of the UPS.

3.03 TESTING

Testing the full load using **dummy load** to be available on site on contactor Responsibility.

PART 4 -Technical Specs for 60VA UPS System

Output Specs:

- Three Phase + N + PE
- AC Voltage Regulation (Battery Mode): 380/400/415 VAC ± 1%
- Output Power Factor: 0.9
- THD ≤ 1%.

Batteries Specs:
- Backup time: 10 minutes
- Sealed Lead Acid Maintenance free long life high rating batteries.

Monitoring Specs:
- LCD Touch Screen
- Multi communication interface: including RS232; RS485 and Dry contacts.

UPS Network Management Card with Environmental Monitoring Requirements:

The network management card shall:

- provide network connectivity options, including Ethernet ports (typically RJ-45) for connecting to a local area network (LAN) or wide area network (WAN). This shall allow for remote monitoring and management of the UPS systems.

- enable real-time monitoring of UPS status, including input/output voltage, battery charge level, load level, and other important parameters. This information shall be accessible through a web-based interface or can be integrated into network management systems.

- log important events and alarms generated by the UPS system. It shall send email notifications or Simple Network Management Protocol (SNMP) traps to alert administrators about critical events such as power failures, battery status, or UPS faults.

- allow administrators to remotely manage and control UPS systems. They shall be able to initiate system tests, configure shutdown and reboot schedules, adjust alarm thresholds, and perform firmware upgrades, all through a web-based interface.

- Some models of the network management card are required to include built-in environmental sensors to monitor temperature and humidity levels near the UPS system. This feature shall allow administrators to monitor and respond to environmental conditions that may impact UPS's performance.

- to be seamlessly integrated with UPS systems. It shall also be integrated with power management software such as Network Shutdown, as well as third-party network management systems through SNMP or other protocols.

- provide various security features to protect the UPS and network infrastructure and it's required to support authentication and authorization mechanisms, such as user account management, password protection, and secure communication protocols like HTTPS and SSH.

- Allow multiple users to access and manage the UPS system simultaneously, with configurable access levels and permissions. This feature shall enable distributed management and collaboration among administrators.

END OF SECTION

SECTION 16620

EMERGENCY GENERATING SET AND AUTOMATIC TRANSFER SWITCH

This section describes packaged type diesel electric LV Standby Power Generation System with weather and acoustic enclosures, as defined by ISO 8528 – 1 2005 for a Limited Time Running Power (LTP including, but not limited to, daily fuel storage tanks, lubrication system, control panels, operating system (hardware and software) and all associated devices and equipment. The ratings of the generators, circuit breakers, instrumentation transformers, and any other parameters are to be as per the tender drawings, wherever they are mentioned, otherwise the site engineer shall be consulted prior to the execution.

PART 1 - GENERAL

1.01 INTRODUCTION

Engine, alternator, controller, ATS and canopy (super silent with sound proof canopy) must be from the same manufacturer.
This section includes a full-packaged engine-generator, ATS suitable for use in Standby applications with the features as specified and indicated. Engine generators will be used as the Standby power source for the system, but shall be capable of providing reliable power with no run-time limitations while the primary source of power is unavailable.

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. The electric power generating system shall have a site capability 0.80 power factor, 400 volts, Wye connected, three-phase, 50 Hertz. This power shall be applied for Standby operation.

1.02 DEFINITIONS

A. Emergency Standby Power (ESP): Per ISO 8528: The maximum power available during a variable electrical power sequence, under the stated operating conditions, for which a generating set is capable of delivering in the event of a utility power outage or under test conditions for up to 200 hours of operation per year with the maintenance intervals and procedures being carried out as prescribed by the manufacturers. The permissible average power output (Ppp) over 24 hours of operation shall not exceed 70 percent of the ESP unless otherwise agreed by the RIC engine manufacturer.
B. Prime Power (PRP): Per ISO 8528: The maximum power which a generating set is capable of delivering continuously whilst supplying a variable electrical load when operated for an unlimited number of hours per year under the agreed operating conditions with the maintenance intervals and procedures being carried out as a prescribed by the manufacturer. The permissible average power output (Ppp) over 24 hours

of operation shall not exceed 70 percent of the PRP unless otherwise agreed by the RIC engine manufacturer.

C. Limited Time running Power (LTP): Per ISO 8528: The maximum power available, under the agreed operating conditions, for which the generating set is capable of delivering for up to 500 hours of operation per year with the maintenance intervals and procedures being carried out as prescribed by the manufacturers.
D. Continuous Operating Power (COP): Per ISO 8528: The maximum power which a generating set is capable of delivering continuously whilst supplying a constant electrical load when operated for an unlimited number of hours per year under the agreed operating conditions with the maintenance intervals and procedures being carried out as a prescribed by the manufacturer.

PART 2- MATERIALS

2.01 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.
B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

    1. Rigging Information: Indicate location of each lifting attachment, generator-set center of gravity, and total package weight in submittal drawings.

C. Capacities and Characteristics:
    1. Power Output Ratings: Electrical output power rating for Standby operation as shown on the drawings, at 80 percent lagging power factor, 230/400, Series Wye, Three phase, 4 -wire, 50 hertz.

    2. Alternator shall be capable of accepting maximum load in a single step and be capable of recovering to a minimum of 90% of rated no load voltage. Following the application of the specified kVA load at near zero power factor applied to the generator set.

    3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component. The engine-generator nameplate shall include information of the power output rating of the equipment.

D. Generator-Set Performance:
    1. Steady State Voltage Operational Bandwidth: 0.5 percent of rated output voltage from no load to full load.
    2. Transient Voltage Performance: Not more than 30 percent variation for 100 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 4 seconds. On application of a 100% load step the generator set shall recover to stable voltage within 10 seconds.

3. Steady-State Frequency Operational Bandwidth: 0.25 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Not more than 7 percent variation for 100 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within 5 seconds. On application of a 100% load step the generator set shall recover to stable frequency within 10 seconds.
6. Output Waveform: At full load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for any single harmonic. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50.
7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 8 seconds without damage to generator system components. For a 1-phase, bolted short circuit at system output terminals, system shall regulate both voltage and current to prevent over-voltage conditions on the non-faulted phases.
8. Start Time: Comply with NFPA 110, Level 1, Type 10, system requirements.

A. The emergency generating set mounted with the following capacities
One (AS PER BOQ KVA) standby power generator, 415V

Works shall include the following:

1. Ventilation fan, ductwork, and electrical circuit.
2. Electrical control wires from the generator to the automatic transfer switch.
3. Louvers in the exterior wall at the E/G room.

2.02 ENGINE

A Fuel: ASTM D975 #2 Diesel Fuel

B Rated Engine Speed: 1500RPM.

C Lubrication System: The following items are mounted on engine or skid:

1. Lube oil pump: shall be positive displacement, mechanical, full pressure pump.

2. Filter and Strainer: Provided by the engine manufacturer of record to provide adequate filtration for the prime mover to be used.

3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D Engine Fuel System: The engine fuel system shall be installed in strict compliance to the engine manufacturer's instructions.

E Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.

F Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity and performance.

1. Designed for operation on a single 240 VAC, Single phase, 50Hz power connection. Heater voltage shall be shown on the project drawings.
2. Installed with isolation valves to isolate the heater for replacement of the element without draining the engine cooling system or significant coolant loss.
3. Provided with a 24VDC thermostat, installed at the engine thermostat housing.

G Governor: (electronic type) Adjustable isochronous, with speed sensing. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate as appropriate to the state of the engine generator. Fuel rate shall be regulated as a function of starting, accelerating to start disconnecting speed, accelerating to rated speed, and operating in various isochronous states, the Governor performance should be according to ISO8528 Class G3.

E. cooling System: Closed loop, liquid cooled
The generator set manufacturer shall provide prototype test data for the specific hardware proposed demonstrating that the machine will operate at rated standby load in an outdoor ambient condition of 48 deg C.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Size of Radiator overflow tank: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.

3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Duct Flange: Generator sets installed indoors shall be provided with a flexible radiator duct adapter flange.

F. Muffler / Silencer: Selected with performance as required to meet sound requirements of the application (Critical Type), sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements. For generator sets with outdoor enclosures, the silencer shall be inside the enclosure.

G. Air-Intake Filter: Engine-mounted air cleaner with replaceable dry-filter element and restriction indicator.

H. Starting System: 12 or 24V, as recommended by the engine manufacturer; electric, with negative ground.
1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
2. Cranking Cycle: As required by NFPA 110 for level 1 systems.
3. Battery Cable: Size as recommended by engine manufacturer for cable length as required. Include required interconnecting conductors and connection accessories.
4. Battery Compartment: Factory fabricated of metal with acid-resistant finish.
5. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation. The battery-charging alternator shall have sufficient capacity to recharge the batteries with all parasitic loads connected within 4 hours after a normal engine starting sequence.
6. Battery isolating switch: Rotating handle operated battery isolator with shrouded or covered terminals and with a lockable handle to prevent un-authorized use and/or re-energizing the battery. The rating of the switch in amperes shall be as per the approved manufacturer’s instructions.

7. Battery Chargers: Unit shall comply with UL 1236, provide fully regulated, constant voltage, current limited, battery charger for each battery bank. It will include the following features:
   a) Operation: Equalizing-charging rate based on generator set manufacturer's recommendations shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.

   b) Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 20 deg C to plus 48 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.

   c) Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.

   d) Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

   e) Provide LED indication of general charger condition, including charging, faults, and modes. Provide a LCD display to indicate charge rate and battery voltage. Charger shall provide relay contacts for fault conditions as required by NFPA110

2.03 ALTERNATOR

B. Shall be brush-less, salient pole, revolving field self-regenerating alternator.

C. The alternator shall be of fabricated steel construction throughout with ball and roller bearings, a dynamically balanced rotating field, salient pole construction with heavy damper windings. The machine shall have an A.C. exciter and liberally rated silicon diode assembly with a self-contained excitation system using with transistorized automatic voltage regulator (A.V.R.) and an efficient cooling system

using a centrifugal fan. It shall be screen protected and drip proof with a large terminal box for outgoing cable connections.

D. Positive voltage build-up shall be ensured by permanent magnets in the exciter field. Special windings shall provide power via a silicon rectifier to the exciter field. Constant output voltage control shall be achieved by a transistorized voltage regulator which adjusts the exciter field current to compensate for all normal variations.

E. The A.V.R. and control gear shall be mounted in a component box on the side of the machine using anti-vibration mountings; electrical connections to the A.V.R. shall all be taken through a multi-way plug and socket. All components in the AVR are to be non- encapsulated.

F. Alternator rotor insulation shall be to Class F.B.S. 2757. Standard insulation on other windings to Class E. All windings shall be fully impregnated for tropical climates with high quality oil resistant varnish.

G. Current peaks associated with starting of squirrel cage motor shall be acceptable and the A.V.R. system shall minimize the effect on the line voltage. A compounding circuit consisting of current transformer and rectifier shall be provided.

H. Voltage regulation shall be within +/-2.5 V under all conditions of load, power factor and temperature including cold to hot variation.

2.04 CONTROL CUBICLE

- The control cubicle shall be free standing or resiliently mounted on the main frame of the generating set.
- The freestanding control cubicle shall be of fabricated zinc coated sheet steel folded construction incorporating a lockable instrument and control panel mounted on the top from section and arranged to withdraw on runners for maintenance and inspection. The rear, side and lower front panels shall be detachable for installation and maintenance purposes. Control cubicles shall be finished in enamel paint.
- The set mounted control cubicle shall be fabricated in Zinc coated sheet steel with a full height hinged panel face allowing full access to all components. The cubicle shall have lockable door handle.
- Where engine instruments are fitted; these shall be mounted on a separate engine sub- panel on the set. The D.C. control circuit, battery charring fuses and charge regulator shall be incorporated in the plant wiring terminal box.
- All plant wiring shall be in flexible PVC or PCP impervious to the action of water, fuel and lubricating oil. Interconnecting wiring throughout the set shall be encased in flexible reinforced PVC or metallic conduit.
- Coded ferrules shall be fitted at the termination of each wire in the control cubicle.

The Control cubicle shall incorporate:

1. **Voltmeter with six-position selector switch**
2. **hand voltage trimmer**
3. **Ammeter with four- position selector switch**
4. **Instrument current transformers**
5. **Frequency meter, clock and timer for weekly automatic test runs**
6. **4 pole mechanically and electrically interlocked contactors**
7. **Time delay controller (adjustable) for transfer of changeover switch control**
8. **Adjustable magnetic overload unit switch dashpot time delays.**
9. **Current transformers for the overload units**
10. **Overload indicator lamp.**
11. **Overload re-set push button.**
12. **HRC mains input fuses.**
13. **Set HRC fuses for A.C. instrument and control circuits.**
14. **Set mains and alternator available and on load indicator lamps.**
15. **Engine start push button.**
16. **Fuel on indicator lamp.**
17. **Automatic low oil pressure and high water temperature protection unit complete with individual indicator lamps.**
18. **Over speed protection**
19. **Over speed indicator lamp.**
20. **Fail to start circuit.**
21. **Fail to start indicator lamp.**
22. **Set of relays arranged to sense a total failure droop to approximately 60% of the voltage in any phase.**
23. **Set automatic mains failure equipment.**
24. **Monitoring unit suitable for operating on a rise in the alternator voltage and frequency.**
25. **The starting timer, monitoring unit and the relays shall be of the plug-in type.**
26. **Duty selector switches OFF/TEST/MANUAL/AUTO.**
27. **Mains operated trickle charger with mille-ammeter, switch and fuse.**

Set of alternator, mains and load connections.
Or digital type control panel incorporating the above mentioned items.

The D.C. control circuit and engine driven battery charging equipment and fuses, regulator, ammeter, etc. shall be incorporated in the plant wiring terminal box, and sub-panel.

Under normal mains available conditions the load shall be fed via a 4-pole contactor. When the mains fail i.e. remain below and adjustable level setting 60%-90% from rated voltage) for an adjustable period of time (setting 0-60 seconds) this contactor shall be released and the plant started automatically. An adjustable time delay control (setting 0-5 minutes) shall be provided controlling the changeover contactors

after rated voltage frequency are available on the generator. Changeover shall be possible both automatically and manually. The load is then to be fed from the generator via a second contactor until the mains are restored when the contactors shall revert to the main available condition and the plant shut down the transfer to normal mains shall be controlled via a time delay unit (0-30 minutes) adjustable.

Cubicle shall be manufactured by the same manufacturer of the engine and/or the alternator.

PART 3 – EXECUTION

3.01 BASE FRAME CONSTRUCTION

A. The combined engine-generator unit shall be bolted to a separate sub-frame which will be attached to a main-frame resilient mountings under the set will be installed on the concrete raised pad.

3.02 FUEL TANK

B. A set mounted fuel tank with sufficient fuel capacity for at least 8 hours' operation on full load shall be provided. The fuel tank shall be mounted on framework attached to the main frame of the generating set. A dial type fuel gauge, fuel filter inlet and outlet connections, drain plug and all feed and return fuel pipe connections shall be provided.

C. An additional outdoor fuel tank shall be provided constructed from black steel 2mm thick minimum with fuel capacity for at least 48 hours. Located as per The Engineer instructions.

3.03 LIFTING

The set shall have four lifting points in the base-frame and skid formed ends to the base-frame.

3.04 ACCESSORIES

The set shall be supplied with a basic tool kit engine maintenance handbook spare parts manual and generating set instruction handbook.

3.05 FINISH

All sheet steel used shall be zinc coated for rust protection. Sets shall be painted with an etching primer and finished with high gloss gray paint.

3.06 STARTING BATTERIES

Battery shall be lead acid type with plate cells contained in molded containers. Capacity shall be as required by the generating set's manufacturer.

3.07 BY-PASS SWITCH

By pass switch shall incorporate three mechanically inter locked triple pole and neutral switches with interlocks and housed in a wall mounting sheet steel cubicle.

3.08 BATTERY CHARGER

Charger shall be of the static, automatic, and constant voltage type. The battery charger shall be capable of returning the batteries for the engine to full charge within 4 hours after use

3.09 AUTOMATIC TRANSFER SWITCHES

ATS must be from the same generator's manufacturer (ONE PACKAGE)
Rating and Performance: The automatic transfer switch shall be 4 –pole 300A and rated for continuous duty operation in local ambient temperature. The transfer switch shall be rated for all classes of load, both inductive and non-inductive, at 415 volts and rating as shown on drawings. The automatic transfer switch shall be designed, built and tested to close on an inrush current of 20 times the continuous rating of the switch without contact damage, capable of withstanding the system fault clearing time of the over current device and capable of enduring 3000 cycles of operation at rated current without failure. One cycle shall consist of one complete opening and closing of both sets of contact. The transfer switch shall be operated from the source to which the load is to be transferred. The time of transfer in either direction shall not exceed one half second.

Operation: Upon failure on any of the phases or substantial drop of voltage (adjustable from 60-80% of nominal), the automatic transfer switch shall signal the emergency generator to start, when the emergency power attains approximately 90% of rated voltage and frequency, the automatic transfer switch shall automatically transfer the load to emergency power. When the normal power returns to above (adjustable from 80% to 90%) of normal voltage. The automatic transfer switch shall sense this and retransfer the load from emergency power to normal power, and signal the emergency source to stop. If the emergency source should malfunction while furnishing power to the load, the transfer switch shall automatically disconnect the load from emergency power to allow restarting (at least 5 times) the emergency source with no load connection. The automatic transfer switch shall include a disconnect device to electrically disconnect the control section from the transfer switch to permit safe access for maintenance or service during periods of normal operation. Failure of any-coil or disarrangement of any part shall not allow the switch to remain in a neutral position with both sets of main contacts open. If emergency source

fails, transfer switch shall retransfer back to normal if available without time delay. A by-pass switch shall be in corporate as shown on drawings and as herein specified before.

Construction: The automatic transfer switch shall be electrically and mechanically interlocked to positively prevent the load from being simultaneously energized by normal and emergency power. The transfer switch shall be provided with a manual operator, which shall provide the same contact-contact transfer speed as the electrical operator. The manual switch shall not cause injury to an operator if the switch transfer mechanism becomes energized during manual operation.
All load contacts shall be silver surfaces, provided with arching tips, and are extinguishing devices. Automatic transfer switch shall be enclosed in a NEMA type 1 enclosure.

Control accessories shall mount on a dead-front panel. Indicating lamps and meters shall be in front mounted meter panel to be visible without opening doors.

The automatic transfer switch, which without restricting generally of the foregoing shall include the following features:

Full phase relay protection with three voltage sensing relays.

Time delay starting: An adjustable time delay from 1 sec. to 5 minutes shall be provided to prevent the emergency power source from needless starting and stopping during periods of momentary voltage fluctuation from the normal power source.
Retransfer time delay: An adjustable time delay from 0 to 60 minutes shall delay retransfer to normal to avoid short term normal power restoration.

1. After transfer to normal emergency generator shall run for a period 5 minutes before shutdown.
2. Test Switch marked Test-Off –Auto for test operation of standby plant and transfer switch.
3. Pilot lamps to indicate presence of all three phases of normal source and to indicate switch position.

B. Painting: Exterior surfaces of the equipment shall be painted with two coats of acceptable oil and heat resistant paint, applied after the surfaces have been thoroughly cleaned and prepared with a suitable priming coat.

C. Spare Parts engine, generator, and ATS: The Contractor shall furnish the spare parts normally provided plus the following:

1. Two sets of filters for all services.
2. Two spare injectors.

Spare parts shall be packed in suitable containers of boxes bearing labels clearly designating the contents and the piece of equipment for which they are intended.

Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall stand safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.

3.10 INSTALLATION AND TESTING

1. Gen-set shall be installed in its place in the Generator room on the anti-vibrating base,
2. Site testing of gen and ATS shall be carried out in the presence of the engineer.
3. Testing the full load using dummy load to be available on site on contactor responsibility.

3.11 MAINTENANCE AND WARRANTY

A. Initial maintenance: For a period of 24 months following date when Gen-set and ATS are completed and placed in operation, provide full free maintenance of GEN SET and ATS. Correct operational faults and restore / replace defective / deteriorated components and finishes. Lubricate operational units and supply expendable materials as required for proper operations and maintenance. EVERY 4-MONTHS maintenance visit should be conducted and recorded. The price includes a two-year free maintenance written contract with the local agent supplier labor and parts, back to back through the contractor.

END OF SECTION

SECTION 16640
EARTHING

PART 1 - GENERAL

1.01 The earthing system shall comply with the requirements of BS 7671 IEE Wiring Regulations, 17th Edition, and local codes and regulations.

1.02 The earthing installations shall provide that all exposed conductive parts and extraneous conductive parts in the building are equipotentially bonded, so that in the event of an electrical fault potential differences are not present.

1.03 All metallic equipment enclosures, steel conduit system, cable trays, trunkings, lighting fixtures, earthing pins of sockets, mechanical services, pipe work and ductwork, tanks, shall be bonded to the electrical earthing system.

1.04 The earthing conductor shall be adequately sized and sufficient low resistance to carry the maximum fault current for a period equivalent to the clearing time of the protective equipment without undue temperature rise.

1.05 All earth connections shall terminate finally at the main low tension switch board earth bus and extended from there to earth electrodes as specified hereinafter.

1.06 The earthing system of the building shall be an independent system connected to the earth bus on the main low tension switch board. The neutral shall not be used for earthing and shall be connected to its neutral bar at the main low tension switch board.

1.07 A separate earth conductor in addition to the circuit wiring shall be included. The earth conductor shall be installed in the same conduit with the phase and neutral conductors and shall be sized in accordance with the local and international codes and regulations.

1.08 The complete earthing system shall be protected against damage by corrosion.

1.09 SUBMITTALS

- Submit test reports of electrical resistance to earth.
- Indicate layout for ground ring(s), showing system earthing electrodes connections and routing of earthing conductors.

PART 2 - PRODUCTS

2.01 Connections between the earthing rods and the MDBs shall be made using copper stranded cable of appropriate cross sectional area (as indicated in the drawings and as per the BS 7671 IEE Wiring Regulations, 17th Edition), with an overall green or green/yellow PVC sheath.

2.02 All earthing conductors, tapes shall be of high conductivity tinned copper and having a minimum cross section of 25x3 mm.

2.03 Where armored cables are installed directly in the ground then the armoring must be bonded to earth using suitable glands. The armoring must not be used as the sole earthing conductor. Additional earthing shall be provided by means of a separate insulated PVC-copper cable whose insulation is green/yellow. This cable shall follow the same route as the supply cable.

2.04 EARTHING RODS

Earthing rods shall conform to BS 7430 and BS 6651 requirements.

Earthing rods shall be of 20mm in diameter by 3 meters length power driven vertically in to the ground with heads located at a depth to suit the position of the disconnecting earthing pit.

Earthing rods shall be solid copper rods, the rods shall be provided with special hardened tips and caps, to avoid distortion when driven into the ground. Non-ferrous clamps for connecting the rod to the copper conductor will be provided.

One end of the rod shall be pointed without application of heat and driving head shall be provided at the other end. The sectional rods shall be coupled with strong bronze couplers. The coupler shall be threaded to fit the rod section. The rod shall be driven into the earth by means of a power hammer.

The head of the earthing rod will be brought to a concrete chamber to be disconnected for testing purposes.

Concrete disconnecting pit with removable cover and disconnecting link, for location and test purposes, will be provided. The top of the chamber will be at finished ground level.

Joints at the head of the earth rods shall be easily accessible for periodic inspection.

Disconnecting bolts, nuts, locknuts and washers shall be made from phosphor bronze.

The copper PVC insulated wires connecting the earth rods to the test link shall be exothermically welded at the test link and sweated to the top of the ground rod.

2.05 ACCESSORIES

All accessories associated with the Earth System shall be of high conductivity copper and factory made. The chief ones are:

Tape Clips

D.C. Clips

Test Clamps

Various types of brackets.

Earth bonds.

Earth Bars.

2.06 INSPECTION PITS

Unless otherwise indicated, connection between an earth conductor and its associated earth rod system shall be in an enclosure.

Every connection of an earthing lead to an earth shall be made in an inspection pit measuring 300mm x 300mm x 300mm (LxWxH), and the connection shall be either welded or clamped. The pit shall be filled with sand and a removable cover placed on each pit.

The enclosure shall have a removable top cover which shall be flush with finished ground level. The enclosure shall be purpose made concrete

inspection pit, a galvanized steel inspection pit embedded in concrete, an earth electrode connection shall be just below the lid of the inspection pit with adequate access for testing purpose.

Backfill immediately surrounding electrodes shall be of low specific resistivity and good water retention properties and it shall be well compacted and watered.

Where earth electrodes are to be installed through the base slab of a building, double flange earth rod seal shall be provided. Then, either the rods shall be driven and the seals fitted before the concrete is poured or the seals handed to the contractor to incorporate them in the slab and the rods driven

at a later date. Harmful ingress of water shall be avoided when driving the rods.

Earth Pit Cover shall be of heavy duty construction.
Earth Pit Cover shall have a recessed lifting hook.
Earth Pit Cover shall have a brass plate, engraved "Electrical Earth Below ."

PART 3 - EXECUTION

3.01 The earth tapes shall be connected to the low-tension switch board earth bus.

3.02 All distribution boards, switch fuses and isolators shall be provided with an earth bus or earth terminal, and these shall be connected to the earth bus in the main switch board by earth conductors included with the feeders.

3.03 Connection between earth bars and equipment frames and stranded copper cables shall be made with appropriate compression lugs, bolts, nuts and lock washers. Contact surfaces shall be thoroughly cleaned and tinned.

3.04 Lugs, bolts, nuts, washers, screws, clamps, cleats and other items which come into direct contact with copper earth bars, tapes, cables, ...etc. shall be non-ferrous and manufactured from brass, bronze or other suitable conducting material which will not cause electrolytic corrosion. Connection between copper and galvanized structures shall additionally be tinned.

3.05 The maximum earth resistance as measured at the earth bus shall not be more than 1 Ohms. If this resistance cannot be obtained with two earth rods, additional earth rods or sectional earth rods shall be used to obtain the required resistance. Parallel connected earth rods shall be spaced at a distance of not less than the rod lengths and connected by 25 x 3mm. copper tape. If approved by the Engineer, earth plates or other earthing means may be used instead of the additional earth rods

3.06 The connection between earth conductors and earth rods shall be made by means of high strength corrosion resistant copper alloy connector clamps.

3.07 The tops of the electrodes shall be protected from any damage and shall be easily accessible. With a view of this, they shall be enclosed in pits equipped with covers. The presence of the electrode shall be indicated in English.

3.08 Measurement of the earth resistance will be implemented after erection the earthing system and this resistance will not exceed 1 ohms.

END OF SECTION

SECTION 16670

LIGHTNING PROTECTION

PART 1 – GENERAL

1.01 SECTION INCLUDES:

Lightning Protection System including, but not limited to the following:

Air Terminals.

Copper Tape.

Grounding Rods.

Grounding Pits.

1.02 RELATED SECTIONS

Section 16000Common Electrical Work Results, General.

A-Section 16640 Earthing system

1.03 REFERENCES

BS EN 62305- Parts 1-4 latest version.

British Standard Code of Practice C.P. 326-1965.

Local Codes and regulations.

1.04 SYSTEM DESCRIPTION

The purpose of the lightning protection system is to minimize the effects of a lightning strike to the building, from above or from the side, and to safely conduct the discharge to earth without side flashing and without danger to personnel.

Description: A Complete lightning protection system including air terminals, down conductors, roof conductors, interconnecting conductors, grounding pits and bonding to protect the building from lightning strikes based on " Faraday`s Cage Principle". Test joints shall be provided as required to make routine tests of the system.

The entire lightning protection system shall be the product of one manufacturer. Subject to the requirements of this Specification & architectural considerations, all items shall be installed in accordance with the manufacturer's recommendations, including fixing to the fabric of the building.

Natural conductive elements of the building such as metal roofs, columns and framing, reinforcement, foundations …etc shall be used as part of the lightning protection system as per the conditions mentioned in the local and international standards.

Waterproofing of the building shall not be impaired in any way by fixings or by any part of the lightning protection system.

The lightning protection system will encompass Air Terminal, copper tapes, down conductors, earth pits...etc. The system shall comprise the following elements:

- **Air Terminals**
- **Copper Tapes**
- **Joints, clips, nuts, bolts and Clamps**
- **Down conductors**
- **Earth Pits**
- **Bi metallic test clamps**
- **Electronic Surge Protection Devices for power & telecommunication systems.**

1.05 SUBMITTALS

Submit manufacturer's data, illustrated leaflets, dimensions, fixing details and description of the proposed products.

Shop Drawings: Indicate layout of air terminals, grounding electrodes, and bonding connections to structure and other metal objects. Include terminal, electrode, and conductor sizes, and connection and termination details.

Test Reports: Indicate procedures and results for specified factory and field testing and inspection.

The Contractor shall submit samples of materials to the Engineer for his approval before placing an order of material.

1.06 QUALITY ASSURANCE

Manufacturer: Firm regularly engaged in the manufacture of Lightning Protection Systems, whose products have been in satisfactory use in similar service for not less than 10 years.

Installer: Authorized installer of manufacturer with minimum three years experience.

Lightning protection system shall comply with the requirements and recommendations of latest version of BS EN 62305 and with the relevant sections of the earthing code BS7430. Where this Specification calls for higher standards the Specification shall prevail.

Maintain two copies of each document on site.

1.07 DELIVERY, STORAGE AND HANDLING

All products shall be carefully packed to avoid damage during transportation.

PART 2 - MATERIALS

Acceptable materials are:

Copper at 98% conductivity when annealed.

Copper alloys provided they are equal to copper in resistance to corrosion.

Grade and quality of materials and the dimensions of components shall be as detailed in BS EN 62305:2006.

All fittings, fixings, supports etc, shall be purpose made for lightning protection.

Joints in conductors shall be kept to a minimum & shall be both electrically and mechanically sound and constructed to prevent the ingress of moisture.

All contact between dissimilar metals or between a metal and a material with which it might react shall be avoided, except as permitted in BS EN 62305:2006 and provided all the precautionary measures recommended are employed. If necessary to prevent long-term corrosion, additional precautions shall be taken such as separation or the insertion of an intermediate material with which neither of the dissimilar metals/ materials reacts, or by changing the metal or material.

Air Terminals:

Material: High conductivity Copper.

Length: 1 meter with saddle base (subject to contractor's risk assessment study and calculations)

Diameter: 16mm.

Copper Tape:

Material: High conductivity Copper.

Size: 25 x 3 mm

Finishing: copper bare for below grade installation and PVC copper on roof

Fastening: Copper clamps at every 1 meter.

Accessories: Test clamp, Cross clamp, tape to metal clamp, exothermic metal welding to re-enforcing bars …. Etc all as recommended by vender.

Grounding Rods:

Material: High conductivity Copper.

Size: 3000 mm solid copper rod.

Diameter: 20mm

Grounding Pits:

Material: Concrete.

Size: 300 mm x 300 mm x 300mm with cover.

Down Conductors:

25 x 3 mm high connectivity copper tapes.

To use reinforcing bars as down conductors if achieving requirements of BS EN 62305-3 regarding continuity of reinforced concrete steel bars (0.2 Ohm) measured from the top of the reinforcement bars down to their bottom ends.
Conductors connecting between a test clamp on the outside of a building and an earth electrode, & conductors interconnecting pipe electrodes, shall be sheathed; but conductors interconnecting copper electrodes may by left bare. Conductors in other locations shall be sheathed. Sheaths shall be of PVC; extruded, shrunk on or similarly applied, the color shall be approved by

ENGINEER.

Where the profile of the building consists of an overhang or re-entrant loop to be formed in a down conductor, ENGINEER shall be informed.

Metal work, including pipe work, duct work, A/C units, pumps, ...etc and armored cables, adjacent to down conductors shall be bonded.

Where reinforcement of a concrete structure forms the down conductors, welding of the reinforcement bars will be carried out by CONTRACTOR. The electrical continuity of the welded reinforcing bars shall be tested prior and after each pour of concrete is completed.

Joints:

Joints in conductors shall be kept to a minimum.

All contact surfaces shall be thoroughly cleaned and coated with an anti-corrosive electrical jointing compound suitable for the conductor material. For bi-metallic joints a separate abrasive shall be used to clean metal.

Joints between conductors of the same metal, other than at test points, shall be made by thermal welding process or by riveting and sweating. Overlap of conductors shall be not less than 100mm.

Except in the case of natural down-conductors combined with foundation earth electrodes. A test clamp shall be provided in each down conductors, it shall be located 1m above ground level unless otherwise indicated. Test clamps shall be of cast gunmetal.

Bonding connections to other metal parts of the building shall be electrolytically compatible with those metal parts.

Screws and rivets shall be of the following materials:

For copper conductors, phosphor bronze, naval brass or high tensile manganese brass.

Joint connections shall be protected by a coating which will form a seal and exclude moisture in all weather conditions. At connections to earth electrodes the coating shall cover all exposed conductors and, in the case of earth pipes, the top surface of the flanges. Protective coatings shall be of waterproof, inert, tenacious material and of one of the following forms:

Solvent cutback thixotrodic corrosion preventative forming a film of resilient matt petroleum wax:

A fast drying durable rubberised sprayed coating.

A heat-shrink clear sheathing.

Conductors:

Earthing conductors, main earthing rods and main bonding conductors shall be of the type, size and conductor materials as detailed or approved by ENGINEER.

Tapes shall comply with BS 1432 where used to interconnect copper electrodes. The tape may be bare for interconnecting pipe electrodes and for all other purpose the tape shall have an extruded PVC sheath.

Main earthing bars shall comply with BS 1433 and shall be bare.

Cables shall comply with BS 6004, Table 1, without sheath, unless specified otherwise M. Earth Electrodes: Refer to earthing system specifications section - 16640.

Fixing:

ENGINEER's approval of the tape clips, saddles and holdfasts used shall be obtained before work is commenced. The maximum spacings of fixings shall not exceed 600mm or the approved manufacturer's instructions. No fixing shall be made into joints in masonry.

For copper conductors or gunmetal, aluminum-silicon bronze or naval brass.
Clips shall be either of metal as above or of outdoor grade polycarbonate or polypropylene with Snap-On lids which cannot be inadvertently removed. Clips and saddles shall have rounded edges and countersunk screws. Brass components shall not be used.

For general areas inside the building screws and nuts shall be of cadmium electroplated steel or stainless steel; outside building, in plant rooms or other locations they shall be of stainless steel.

No shot firing shall be used and no drilling or welding of structural steelwork shall be carried out without the approval of ENGINEER. Drilling and cutting of the outside fabric of the building shall be carried out only after approval has been given by ENGINEER.

Inspection Pits: Refer to earthing system specifications section - 16640.

PART 3 - EXECUTION

3.01 INSPECTION

A. The Contractor shall examine the areas and conditions under which lightning protection systems are to be installed and correct any manufacturing conditions detrimental to the timely and proper completion of work. He shall not proceed with the work until conditions are satisfactory and in a manner acceptable to the Owner.

3.02 INSTALLATION

Conductor links to the earth electrodes shall be 25 mm. x 3 mm. copper tape run in non-metallic pipes from the earth pit to the down conductor. The copper tape shall extend 600 mm. above ground/finished floor level where copper joint shall be made.

All metal equipment and works on the roof (VRF, Pumps, fans, etc.) shall be bonded to the roof copper tape networks.

Provision shall be made for expansion and contraction of conductors and special care shall be taken in the fixing of supports to allow for movement.

Joints in down conductors shall not be permitted.

Where joints are permitted in other than down conductors, they shall be riveted and bound in "Denso" tape. Joints below ground level shall not be tinned but shall be protected by two coats of bituminous paint and wrapped with two layers of "Denso" tape.

Connections between conductors and earth electrode clamps shall be similarly protected. Wrapping shall extend each side of the joint Except in the case of natural down-conductors combined with foundation earth electrodes. Copper test clamps shall be installed for all vertical down conductors at a mounting height of 1000 mm above finished ground level.
Main earth electrodes shall be of the copper rod type, (L = 3000mm diameter = 20mm.) driven vertically into the ground within earth pit. The terminal end shall finish 300 mm. below finished ground level covered by a concrete inspection pit.

Overall, the earth resistance shall not exceed 1 ohms.

The Contractor shall include for tests for resistance to earth of each termination, continuity of conductors and efficiency of bonds and joints. The Contractor shall supply all labour and instruments to conduct these tests. All tests shall be carried out in accordance with paragraphs 303 and 304 of the British Standard Code of Practice No. C.P. 326-1965.

END OF SECTION

Section 16720
Public Address System

Part 1 – General

1-1 Description of Work

The system will diffuse in the common space voice alarm or selected music emitted from recorded tapes and/or CDs, radio stations as well as public address for microphone station main other area for the system is voice alarm and evacuation system.

The sound system shall be designed and manufactured to meet all requirements needed for the modern up to-date technology to suit the function of the project.

The design drawings and technical specifications presented by the Engineer specify the general minimum requirements for sound systems proposed of this project.

The contractor's scope of work through a professional sound system supplier / sub -contractor shall include the design, supply, install, test and commission a comprehensive latest technology sound system as generally shown on the drawings and specified here within.

The sound system shall include but not limited to all rack mounted amplifiers, line amplifiers, digital signal processors, microphones, tone selection/control equipment, input stations, loudspeakers, power connections, interfacing modules, rack consoles, cables and terminations.

The sound system works shall be carried out by a specialist subcontractor approved by the client and the Engineer.

The specialist sound system sub-contractor shall submit detailed workshop drawings, backed up with detailed calculations for the required number and ratings of all amplifiers, and speakers, in addition to the best location of speakers for optimum coverage and best sound quality and intelligibility, all shall be subject to the Engineer review and approval.

Not all the mentioned items specified in the specification are required in the contract, some items shall be submitted and installed by others, refer to B.O.Q. for included items.

1-2 Quality Assurance

1. Materials and equipment shall conform to the latest edition of reference specifications specified herein and to applicable codes and requirements.
2. Manufacturer's Qualifications: Firms regularly engaged in the manufacturer of voice alarm and music system, of types specified whose products have been in satisfactory use in similar service for not less than 5 years. A list of installed systems of the same type as specified shall be submitted to the Engineer. The manufacturer or his authorized distributor shall confirm that within a reasonable distance of the job site there is an established agency which stocks a full complement of parts and offers service during normal working hours on equipment to be furnished, and that the agency will supply parts without delay.
3. Factory, Testing and Inspection: The manufacturer shall thoroughly test the assembled system for proper functioning and compliance with the specifications. Submit certification to the Engineer that this testing has been completed and that the function and compliance conforms to the specifications.
4. Coordination: coordinate with the related work specified elsewhere under this and other divisions of the specifications.

1-3 Submittals

1. Submit the following in accordance with Submittal Requirements specified in the related Section.

A. Product Data: Submit manufacturer's technical data, including specifications concerning installation and operation instructions for each type of equipment.

B. Shop Drawings: Submit shop drawings showing equipment/device locations, wiring and riser diagrams for the entire system.

C. Maintenance Data: Submit maintenance data and parts list for each type of equipment installed, including devices and accessories. Include this data, product data and shop drawings in maintenance manual.

1-4 Delivery, Storage and Handling

1. Handle equipment carefully to prevent damage, breaking and scoring. Do not install damaged components; replace with new.
2. Store equipment in a clean, dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage. Assume responsibility and security for materials and equipment.
3. Each packing crate and carton shall be visibly marked to identify contents as to types, units, and related equipment assembly .

2.1 SYSTEM CONTROLLER : -

SPECIFICATIONS

1- Alarm, prerecorded and live messages.
2- Music broadcasting.
3- Microphone desks connected by bus or through the corporate data network.
4- Output/input contacts for emergency functions, message activation, zone control.
5- Audio outputs with individual volume control.
6- Control data reception and transmission via IP connection.
7- 350 W rms , 100 V , 220Vac 60/50 Hz
8- 6 speakers Zones and control from microphone desk with Priority.
9- Music Source AM/FM Tuner , CD, MP3 , USB inputs.
10- Microphone desk with minimum 6 zones speakers control.
11- With 10 inputs.

2.2 6W PUBLIC ADDRESS CEILING LOUDSPEAKER

The ceiling speaker should be designed specifically for use in buildings where performance of systems for verbal evacuation announcements is governed by regulations. It should be designed for use in voice alarm systems and is compliant with British Standard BS 5839 part 8.

Specifications

Ceiling speaker,

6", 6 W RMS (6, 3 & 1 W), 100 V,

spring catches. White colour

Frequency response of 100-15.000 Hz.

Sensitivity 93 dB , Flush mounting,

2.3 10W PUBLIC ADDRESS WALL LOUDSPEAKER

power rating of 10 W (selectable by rear switch to 5, 3 and 1 W),

100 V line

. Frequency response of 150-20.000 Hz.

Sensitivity 90 dB (1 W, 1 m and 1 kHz).

Maximum sound pressure level 98 dB (6 W, 1 m and 1 kHz).

2.4 Handheld dynamic microphone For Prayer Area

Handheld dynamic microphone 250 Ohm with unidirectional cardioid polar diagram.

Frequency Response 50 ~ 16,500 Hz.

Sensitivity -77 dB at 1 kHz.

Steel body, with on-off switch and XLR connector.

Part 3 – Execution

3-1 Wiring

1. The contractor should provide and install all wiring and accessories needed to deliver a complete turnkey system.
2. For loudspeaker lines, the used cable shall be of the 1-pair copper twisted type, or approved equal:
3. Wiring shall be installed in conduits or on cable trays.
4. Wiring shall be as recommended by the manufacturer. Wiring requirements for shielding certain conductors from others or routing in separate conduits shall be as recommended by the manufacturer.

3-2 Identification

1. Lines shall be clearly identified.
2. Equipment shall be numbered and coded.

3-3 Workmanship

3-3-1. Examination

A. Examine conditions at the job site where electrical work is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

3-3-2. Preparation

A. Examine the Contract Drawings and specification in order to insure the completeness of the work required under this Section.

B. Verify measurements and dimensions at the job site and cooperate in the coordination and scheduling of the work of this Section with the work related trades, so as not to delay job progress.

C. Provide templates as required to related trade for location of items.

3-3-3. Installation

A. Install system in accordance with the applicable electrical codes and requirements. Install equipment in accordance with manufacturer's written instructions. Panels shall be mounted with sufficient clearance for observation and testing.

B. Wiring Methods: Install wiring in conduit or on cable tray except within consoles, desks and counters.

C. Wiring within Enclosures: Provide adequate length of conductors. Bundle, lace and train the conductors to terminal with no excess. Provide and use lacing bars.

D. Splices, Taps and Termination's: Make splices, taps and termination's on numbers terminal strips in junction, pull, and outlet boxes, terminal cabinets and equipment enclosures.

E. Identification: Use color coding of conductors and apply wire and cable marking tape to designate wires and cables so media are identified in coordination with system wiring diagrams. Transposing or changing color coding of wires is not permissible.

F. Weatherproofing: Provide weatherproof unit where they are to be mounted out-of-doors or exposed to weather in any degree

3-4 Field Quality Control

1. Manufacturer's Field Services: Provide services of a factory- authorized service representative to supervise the field assembly and connection of components and the pre-testing and adjustment to the system.
2. Inspection: Make observations to verify that units are properly labeled, and interconnecting cables and terminals are identified.
3. Retesting: Rectify deficiencies indicated by tests and retest work affected by such deficiencies at Contractor's expense. Verify by the same test that the total system meets the Specification and complies with applicable standards. Provide a written record of retest result

3-5 WARRANTY & MAINTENANCE:

Maintenance: For a period of 24 months following date when the system is completed, placed in operation, & accepted by the engineer provide full free maintenance of the system EVERY 4-MONTHS maintenance visit.

Correct operational faults and restore/replace defective/deteriorated components and finishes. The price includes a two-year (2) free maintenance written contract with the local agent supplier labor and parts, back to back through the contractor.

END OF SECTION

Section 16730
FIRE DETECTION ALARM SYSTEM

PART 1: GENERAL

1. The contractor shall be responsible for the supply, installation, commissioning and servicing of the addressable fire alarm system

2. The contractor must review the consultant's design. All deviations should be brought to the attention of the Engineer.

3. The contractor technical Engineer must have, at least 7 years experience in installing, commissioning and servicing fire detection and alarm systems, at least 5 of which must be with analogue addressable systems, he shall supervised the installation , software documentation , adjustment , preliminary & final testing , commissioning and certification of system, he shall provide the required training to the owner's personal in the system operation, maintenance and programming .he is also responsible of delivered the system to local responsible authority (civil defense department).

4. All equipment central to the operation of the analogue addressable systems shall be designed and manufactured by the company installing and commissioning the system. As a minimum requirement, this clause covers the following:

- Fire Alarm Control Panel
- Repeat Panels
- Addressable ancillary equipment
- Power supplies and automatic point detection equipment

5. The manufacturer shall be complying with BS EN ISO 9001:2008 Quality Management System Standard for the design and manufacture of the equipment.

6. The main equipment proposed for use shall be testing and certified either by one of the following:

- Loss Prevention Certification Board (LPCB)
- Underwriters Laboratories (UL)

7. The manufacturer shall have available a complete set of technical manuals for all equipment installed. This must cover technical specification, system design recommendations and guidelines for installation, commissioning, operating and servicing the proposed equipment.

8. All deviations from this specification that the contractor proposes to make shall.

9. be clearly indicated in writing, referring to the relevant paragraph(s) of this specification.

10. Applicable Standards and Specifications Where applicable, the fire detection and alarm system and installation shall comply fully with the British Standards or NFPA rules and regulations as well as with local fire detection code.

11. OUTPUT SIGNALS UNDER FIRE CONDITIONS

Provision shall be made in the Fire Alarm Control Panel to provide the following:

- Potential free NO/NC contacts or interface as required for the fire door and **elevators**
- Potential free NO/NC contacts or interface as required for shutting or starting mechanical /HVAC equipment such as AHU's, Motorized smoke damper , pumps, dampers, fans VRF… etc as may be required.
- The contractor shall be responsible for providing conduit and wiring from the fire alarm control panel up to the required equipment(s) as mentioned in paragraph 'A' above.

12-SYSTEM DIFFERENCE

There may be some difference between one manufacturer and another. The purpose of these specifications is to lay down the requirements in general for the fire alarm system. The system supplier shall ensure that all functional aspects of the fire alarm system shall be achieved though the equipment specifications one manufacturer may differ from the other in some aspects. It is expected that the system supplied shall be a product of the latest technology only from the specified brands/manufacturers.

13- APPROVALS FROM THE CONCERNERD LOCAL AUTHORITIES (i.e. CIVIL DEFENSE FIRE DEPARTMENT)

A. Before commencing any installation works, the contractor shall obtain the Engineer's approval in respect of the system he is going to use. Based on the contract drawings the contractor shall prepare all necessary drawing with the help of his system supplier (manufacturer). After coordinating with other trades, the contractor shall submit his drawings to obtain the concerned local authorities fire department approval.

B. The contractor shall also be responsible for obtaining all approvals from the concerned local authorities. Civil Defense Department during and after the installation as deemed necessary and as required.

Supply, install, test and commission the fire alarm & detection system as specified, as indicated on drawings and as required as per the concerned local authorities Civil defense department & Regulations.

14- Contractor shall install smoke detectors above false ceiling and also where false ceiling depth is 80 cm (or as per local defense fire department requirements) and above within contract price.

15-The electronically operated analogue addressable system including but not limited to the following items:

- ✓ Fire Alarm Control Panel
- ✓ Fire Alarm Repeater panels (when indicated in drawings)
- ✓ Power supply and standby batteries with charger
- ✓ Smoke sensors
- ✓ Sensor sounders
- ✓ Heat sensors
- ✓ Beam sensors.
- ✓ Manual call points
- ✓ Visual alarms
- ✓ Interface units WITH :

A. System interface with firefighting system (sprinkler, fire extinguishing system), FM200…etc.

a) System interface with HVAC/air handling units.
b) System interface with elevators
c) System interface with smoke and fresh air fans
d) System interface with building management system
e) System interface with escalator
f) System interface with other specifies systems like access control, CCTV…etc.
g) System interface with VES & PA system

Any additional ductwork, encasement works required shall be the responsibility of the contractor. He shall not be entitled for any additional claims on these accounts.

It is assumed that the contractor before signing the contract has reviewed the drawings and ascertained the routes and hurdles.

1.01 DESCRIPTION OF WORK

A. Scope: The work covered by this specification comprises all materials, installation, labor, services, and all equipment and materials necessary to install, operate, test, and commission, including, but not limited to, the undermentioned items:

1. Main fire alarm control panel.
2. Graphic Fire Alarm Monitoring Station
3. Power supply and standby batteries with charger.
4. Manual call points.
5. Sounders.
6. Remote indication lamps.
7. Ancillary services
8. Remote indication lamps.
9. Structural accommodation for services.
10. Siting of control equipment, sounders, visual alarm, detectors and manual call points.

11. Cabling and wiring.
12. Inspection, testing and commissioning.

1.02 QUALITY ASSURANCE

A. The Contractor shall be responsible for the quality of all its purchased items and as such, must develop and submit a supplier quality inspection plan for review. The inspection plan shall cover those items intended for shop inspection and the procedures for carrying out same

B. Manufacturer: Fire alarm and detection system shall be the standard products of a manufacturer regularly engaged in manufacture of fire alarm and detection system of type and sizes required and complying with the requirements of the listed standards and whose products have been in satisfactory use in similar service for not less than 5 years and shall be installed by a specialist.

C. Codes and Standards: Comply with the requirements of the following codes and standards, except as herein modified:

1. Local Authority Standard
2. BSI - British Standard Institution:

2.1 BS 5445- Components of automatic fire detectors system.

2.2 BS 5446- Components of automatic fire alarm systems for residential purposes. Part 1 Point-type smoke detectors

2.3 BS 5839- Fire Detection and Alarm Systems for Buildings.

2.4 BS 7671- Requirements for Electrical Installations.

D. The supplier of Fire Alarm System shall submit certification of registration of fire alarm issued by BSI Quality Assurance or equivalent.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's data on fire alarm and detection systems including, but not limited to, specifications, installation instructions, operation of each component and of the system. Also include standard of typical riser and wiring diagrams.

B. Shop Drawings: Submit shop drawings showing equipment construction, device locations, connecting wiring of the entire fire alarm and detection system, raceway layout, including wiring and riser diagrams.

C. As-Built Drawings:

1. On completion of the installation, adequate instructions on its use shall be supplied to the person responsible for the use of the premises. The Contractor shall draw the attention of the user to the condition of false alarm and servicing.
2. The Contractor shall supply the user with a logbook.
3. As-built drawings shall be provided to the user showing the

position of the various items of equipment, junction boxes, etc. and the sizes and routes of all cables and wires. Wiring diagrams of junction boxes and distribution cases and circuit diagrams of the fire alarm system shall be included.

1.04 TESTING AND COMMISSIONING

A. Equipment Test: Unless a requirement is waived, submit manufacturer's type test reports certifying that components meet specified standards

B. Inspection of Installation: The complete installation shall be inspected to ensure that the work has been carried out in a satisfactory manner and that the methods, materials and components used conform with the specifications, the specified codes and standards

C. Field Tests:

1. Insulation of Cable and Wires: Insulation testing of installed cables and wires shall be made at 500 VDC and the insulation resistance to earth and between conductors of the installed cables and wires shall be in accordance with listed standards.
2. Earthing: Earth continuity and earth-loop impedance shall be tested to ensure compliance with the requirements of the listed standards.
3. Commissioning Test: The entire system shall be tested to ensure that it operates satisfactorily and that:
   - 3.1 The alarm devices comply with the specifications.
   - 3.2 All trigger devices and alarm points function correctly.
   - 3.3 All ancillary equipment functions correctly.
   - 3.4 Any connections to a fire brigade or commercial center operates correctly.

PART 2- PRODUCTIN

2.01 SYSTEM DESCRIPTION

A. General the alarm and detection system shall be analogue addressable system

B. The system shall include but not be limited to the following

a. Addressable main Fire Alarm Control Panel with analogue detection technique with integral battery and charger, in-built keyboard (function key to facilitate on-site programming), in-built printer, visual display unit capable of displaying 4 lines of 40 characters each, indicators to denote “FIRE”, "POWER ON" and "FAULT'

b. Graphic Monitoring Station, UL listed

c. Addressable Manual Call Points.

d. Addressable Fire Sensors with individually adjustable Day/Night alarm

and pre-alarm thresholds,-alarm verification time, alarm priority.

e. Electronic Saunders.
f. Addressable Fire alarm Interface Units.
g. Other Accessories required and Wiring.
h. Auxiliary Components.

C. The system shall as a minimum include the following provisions

a. All necessary software and / or programming to provide a fully comprehensive error checking and signal processing system.
   This shall include analysis of the analogue information received to reduce false alarms incurred by insects, electrical transients, faulty equipment, and the like, together with self- compensation monitoring of sensor threshold levels in order to instigate maintenance warning prior to "FAULT or FAILURE" occurrence.
b. To ensure continuous stability of the system the setting of the address code in each addressable device shall be by means of hardware. Systems based on "Soft Addressing" techniques will not be acceptable.
c. Removal of one or more field devices from a loop circuit shall not in any way impair the correct operation of all other field devices forming part of the loop or system
d. Synchronization of all sounders on the loop circuits whether operating in a continuous or intermittent mode.
e. Identification and display of power supply faults from graphics mimic repeat panels and interface units.
f. Memories up to 100 events (i.e. Fire / Fault / Message) and transfer to same to on-board printer for readout if requested
g. Complete software integration with B.M. S. computer, through twisted shielded bus.
h. Accept, identify and verify it FIRE CONDITION "information received from field devices (fire sensors, manual call points, interface units, etc.,) and operate sounders, all via 2 wire loop circuits with a period NOT IN EXCESS OF 1 SECOND.
i. Graphic Software: designed to integrate with fire alarm system to provide clear & precise real-time information of alarm on PC work station with use of text, floor and maps. The graphic software makes it easy for the user to locate affected area to enable them to make efficient response to emergency by constantly monitoring incoming alarm trouble data, in case of alarm trouble the particular floor will pop-up automatically, and the respective triggered device will flash with change of the color & will provide clear text massage of zone no. device no. and description of device location. The software also has a pass word protection feature that allows only authorized personal to log in log out /change password.

2.02 FIRE ALARM SYSTEM HARDWARE

A. Fire Alarm Panel: The analogue addressable fire alarm control panel with analogue detection technique shall have the following features

1. Multi-Processor controller.
2. Self-contained wall mountable or self-contained and floor standing.
3. Integral switch mode power supply and battery chargers.
4. 24 Hour battery back-up.
5. Printer and full keyboard
6. Twin 24V Master alarm circuits
7. Manned Center link Connection Facility
8. DC Accessory Relay Board Modules with 4 unsupervised relays (2A, 30 VDC Max. resistive loads) each with user-selectable N.O. or N.C. contacts
9. RS232 / RS485 Computer communication, for networking of up to multiple Fire Alarm Panels.

B. Panel User Controls:

1. All controls enclosed behind a lockable cover.
2. Essential controls for fire and evacuate, start sounders, stop sounders, reset, acknowledge.
3. "Silence' fault buzzer facility through acknowledge switch.
4. Time and date setting facility.
5. Master alarm START / STOP controls.
6. Test for liquid crystal display, light emitting diodes and fault buzzer.
7. Printer ON, OFF, LINE FEED and TEST facilities.
8. Disabling facilities for outstations, zones, sectors, auxiliary relays, master alarms.

C. Reports

1. All Points.
2. Alarm summary.
3. Trouble summary.
4. Status summary (all output points).
5. Disable points.
6. Isolated Points.
7. Disconnected points.
8. Sensitivity log.
9. Single point log.
10. Historical log (last 100 COS)
11. Logical point groups.
12. Trend log.
13. Event Log:
14. A log of at least 160 previous Fire, Fault, Warning and status events

D. Time Zone and Delay Block:
   1. 15 Itemize programs over 7 days' period.
   2. Time delays shall be individually adjustable by point
   3. Shall operate with delayed action
   4. Any sectors shall operate other sectors with delayed action
   5. Auxiliary relays shall operate ON or OFF with delayed action

E. System Description
   1. Loop wiring shall be monitored for short circuit with response time of 10 seconds.
   2. Loop wiring shall be monitored for open circuit every 10 seconds or less.
   3. Outstations shall be monitored for disconnection from loop every 10 seconds or less.
   4. All outstations shall be monitored for communication failure.
   5. Loop supply shall be fully monitored.
   6. Local communication card functions and inter-connection of electronics within the panel shall be monitored for fault.
   7. Earth fault, keyboard, and printer shall be monitored for failure.

F. Engineering Techniques

   The response time from the sensing of a threshold at an outstation to appropriate event action being taken by the control panel shall be less than 10 SECONDS, independent of the system size. An even faster response of 1 SECOND should be achieved if the threshold is from a Manual call point within the system.

G. Other Features:
   1. Information retrieval facilities for engineering set-up and system status.
   2. Memory of configuration and engineering set-up.
   3. Clearing Fault and Warning Facilities.
   4. Password protected access to engineering controls

H. Power Supply Unit: A power supply unit shall be provided for each Control Panel forming part of the system, and these shall comply in all respects with the requirements of BS 5839.
   1. Each power supply unit shall be suitable for operating in conjunction with its associated panel and be complete with suitably rated charger, sealed lead acid battery, status control module and interface input /output fuses
   2. Each unit shall be suitable for accepting a 230 volts 50 Hz. A.C. input and have a 28 VDC nominal output suitably rated to operate its panel / interface unit and associated equipment for both normal operating conditions and a mains failure standby period of 24 hours (minimum) with a further 30 minutes under full alarm/control load conditions.
   3. The power supply units shall form composite part of the associated panel / interface unit and due account shall be taken with respect to ventilation requirements. A fan assisted

thermostatically controlled cooling system should be built in to the power supply design for reliable operation throughout the product life

2.03 AUTOMATIC ANALOGUE / ADDRESSABLE FIRE SENSORS

All automatic sensors shall be analogue / soft addressable pattern and comply with the following requirements:

A. Smoke Sensors - Ionization Type:
   1. Comply-where applicable with the requirements of the listed standards.
   2. Contain integral L.E.D. indicator to denote operational mode and provision for connection of a remote led.
   3. Contain all necessary electronic components and circuitry required to form an analogue addressable device for direct connection to the 2 wire loop circuits originating from the central control panel and operate in conjunction with the system circuitry / operational arrangements.
   4. Ionization sensors shall be dual chamber type:

B. Heat Sensor:
   1. Comply where applicable with the requirements of EN 54.
   2. All as previously detailed in A2 and A3 above.
   3. Heat sensing shall be carried out by the thermistor and heat sink assembly. The microprocessor on the PCB performs the monitoring of the THERMISTOR through analogue to digital conversion circuitry.

C. Duct Sensor:
   1. It would use an Optical sensor.
   2. All as previously detailed in A2 and A3 above.
   3. Housing shall include Inlet and Outlet Probes and terminations to the sensor base. PIA
   4. Shall monitor airflow of 300 to 4,000 CFM in ventilation ducts.
   5. Therefore, a correct positioning of duct detectors is a must. Air turbulence caused by bends, fans or obstructions shall be fitted away from these positions. A position shall be selected where a sufficient density of smoke can reach the inlet probe. For this to be achieved, sensors must not be sited in a common duct as this will lead to smoke dilution. That is, air from an area of fire will mix with clean air from other areas and may not satisfactorily operate the sensor within the duct housing. When the probes are correctly aligned in the duct, the air flow along the duct promotes a pressure differential between the inlet and the exhaust probes, causing air to flow through the duct housing. If smoke is present in sufficient quantities in the duct it would be sensed by optical / heat sensor.

2.04 ADDRESSABLE MANUAL CALL POINTS

A. All manually operated contacts shall be addressable pattern and comply with the following requirements:

1. All necessary electronic components and circuitry required to form an addressable device for direct connection to the 2 wire loop circuits originating from the control panel, and operate in conjunction with the system circuitry / operational arrangements.
2. Suitable for both semi-flush and surface mounting.

2.05 ELECTROMC SOUNDERS

1. Shall meet the requirements of B.S. 5839
2. Two link delectable volume
   - 95 dB at 1 meter.
   - 104 dB at 1 meter.
3. Shall be compatible to be connected on the same loop along with addressable sensors and addressable manual call points, through a control module.
4. Cross-Zoning concept shall be available which can be modified and programmed accordingly in the Fire Alarm Panel.
5. Activation, de-activation, enabling and dissembling features shall be available and shall be achieved using the Fire Alarm Panel's keyboard.
6. Shall be suitable for surface mounting.

2.06 ADDRESSABLE CONTROL MODULES

A. All control module operated contacts comply with the following requirements

1. All control modules shall be addressable and contain all necessary microprocessors, electronic components / circuitry required to form an addressable device for direct connection to the 2 wire loop circuits and operate in conjunction with the system circuitry operational requirements.
2. Shall provide single pole double throw switching action for locally powered equipment.
3. The relay coil shall be controlled from the control panel via the 2 wire loop circuits and internal microprocessors / electronic components / circuitry, the contacting being generally utilized to de-energize automatic fire doors and transfer ventilation plants to a fire status under a fire alarm condition.

2.07 DESCRIPTION OF OPERATION

The Fire Alarm Panel shall have individually integrated 2 wire loop circuits distributed to cover the various building levels of the whole development. The various areas of the building have been identified as “FIRE ZONES” and generally operate in the following manner:

A. Alarm Initiation: Should a fire zone contact glass be broken or smoke/heat sensor operate, the following functions where applicable, will operate:

1. Energies the “FIRE” indicators and instigate the L.C.D. to denote address identification and label details, all forming part of the master fire alarm panel.
2. Selected sounder zones to operate on a continuous /intermittent basis as required.
3. Energies the applicable relays, which in turn signals the door holders to open / close, signals the ventilation plant to a fire status and close smoke dampens, Shutdown the A.H.U,'s, bring the **elevators** to the ground floor, signals the B.M.S. which in turn logs the event, etc. Communication to the B.M,S. shall be through software, and that hardwired interface will not be accepted.
4. Retains the event within the master alarm panel memory for logging on the board print if and when required

B. Silence Saunders to silence the activated sounders the following procedures, where applicable will apply:

1. Release key operated hinges access lid to control keyboard.
2. Press "Silence " control key.
3. The function listed above under A (1), (3), and (4) above shall remain active after completion of this procedure.

C. System Reset: To reset the system after completing (2) above, the following procedure, where applicable, will apply:

1. Replace the broken contact glass or check the activated sensor as returned to the normal status.
2. Press "RESET " control key, this operation will automatically extinguish the " FIRE " indicators, remove the information from the L.C.D., all forming part of the master alarm control panel, and extinguish the 'i FIRE ZONE " area / register title L.E.D.'s forming part of the graphic mimic display panel.
3. Signal the B.M.S. which in turn log's the event. All communication with B.M.S. shall be through software and that hardwired connection will not be acceptable.

D. Fault conditions

1. Fault Initiation: Should a monitored loop circuit be subjected to a line break / short / open circuit or an equipment item develop a fault, incurs supply problems, the following functions, where applicable will apply:

- Energies the “FAULT” indicators and instigate the L.C.D. to denote incident location / address and label details.
- Energies the internal fault tone unit.
- Signal the B.M.S. which in turn logs the event; communication with B.M. S. through software.

E. Fault Reset:

F. To reset the system after initiation of (1) above, the following procedure shall apply:

G. Rectification of the fault shall automatically extinguish the "FAULT" indicators, and enable the following automatic facilities to apply.

H. This operation shall automatically de-energize the internal fault tone unit; signal the B.M.S., which in turn logs the event and activates the L.C.D. display to denote the same.

I. Warning Condition:

1. Warning Initiation: Should a field device be changed / replaced for a dissimilar device (i.e. smoke sensor replaced by heat), the following functions, where applicable will operate:

- Energies the "WARNING" indicators and investigate the L.C.D. to denote the incident location / address and label details.
- Energies the internal buzzer.

2. Warning Reset: To reset the system after initiation of (1) above, the following procedure will apply:

- Replace correct type of field device, or; if field device type change is deliberate due to area functional requirements this situation can be accepted via the function keys.
- On Completion of (a) above, the “WARNING” indicators and internal fault tone unit will automatically de-energize.
- If field device is not replaced, the system shall work using the sensor with default settings for the new types, so that the zone/room is still protected
- System check circuitry: This shall incorporate all the necessary requirement to provide a full comprehensive error checking and signal processing system, the operation of which being as detailed for "Fault Condition" above.
- A manually operated control key shall be included, which if pressed will signal all sounders to an "EVACUATE" status. A key operated code system shall be provided within the microcomputer to enable the user to select to retain or delete in any combination the sounders or interface unit relays operation.

PART 3 - EXECUTION

3.1 INSTALLATION

The fire detector shall be normally attached to the ceiling or the suspended ceiling of the room to be protected and shall be arranged so as not to interfere with other installation work and equipment. If attached to the suspended ceiling the detector should be fixed to a firm base supported from the ceiling slab by means of steel conduit to keep them stable. If proved a hindrance, the detectors shall be relocated. At the time of installation, the, exact number and type of the detectors required as and their location shall be finally determined after complete study of the ceiling height or all plans of rooms to be protected along with an equipment layout drawing and the specification of the selected detectors.

Sounders shall be mounted 0.7 meter below the ceiling or the suspended ceiling.

Manual call points shall be located near floor exits in the approximate location shown in drawings and mounted 1.4 meters above the floor level. This part of the work shall be so coordinated with the other services.

3.2 WIRING

A. All cables shall be of the fire rated cable (950c three hours), as shown on drawing.

B. Cables as far as possible shall be routed in protected areas of low fire risk.

C. Conductors shall be copper, each having a cross- sectional area of not less than 1.5 mm2. & 2.5 mm2 for sounders & sounders with flashers or when needed.

D. Cables lay in cavities and voids shall be treated as surface laid cables and they shall be separated from the cables of other services by at least 300 mm.

E. Where cables or raceways pass through floors, walls, partitions or ceilings the surrounding hole shall be made good with fire-stopping material to the full thickness of the separation considered. In addition,) where cables, conduits or conductors are installed in channels, ducts, trucking or shafts that pass through floors, walls, partitions or ceilings, suitable internal barriers of suitable fire-resistant performance shall be provided to prevent the spread of fire.

F. Joints in cables shall not be permitted without special consent of the Engineer. In such a case, joint in cable shall be enclosed in a fire proof and accessible junction box labeled "FIRE ALARM

G. Cables fixed to surfaces shall be neatly run and securely fixed at suitable intervals

H. For stopping mechanical fans and air handling unit motors, cable from the auxiliary contacts to the respective fan starter/control panels shall be wired in accordance with the specifications. These cable sizes and

the rating of auxiliary contacts shall be in accordance with air conditioning requirements. Certain air handling fans require to be stopped by the operation of fire alarm detectors of more than one zone. All auxiliary contacts, controlling and air handling fans shall be wired together, series or parallel as required to the auxiliary contact terminal block and labeled appropriately

3.3 MAINTENANCE AND WARRANTY

Maintenance: For a period of 24 months following date when the system is completed, placed in operation, & accepted by the engineer provide full free maintenance of the system a monthly-surveillance basis. Correct operational faults and restore/replace defective/deteriorated components and finishes. The price includes a two-year (2) free maintenance written contract with the local agent supplier labor and parts, back to back through the contractor.

END OF SECTION

SECTION – 16740
WEB-BASED ACCESS CONTROL SYSTEM

1. SCOPE:

The access control system shall be a completely integrated security solution providing controlled access to the facility at specified locations through the use of high security technology. The system shall provide distributed supervised inputs and outputs to allow for alarms to be detected and triggered. These inputs and outputs shall be configurable via software to control building functions such as power control.

The system control panels will be fully upgradeable using flash memory firmware.

2. SYSTEM ARCHITECTURE:

The access control and alarm monitoring system shall be a flexible single-user, open architecture facility management system. The system shall be designed using reliable state of- the-art technology allowing for easy and economical expansion. The scale able design shall allow for operation from an embedded Web based server without a dedicated server or PC workstation.

The system shall feature embedded Linux software that intelligently controls the reader network to provide automated data collection and configuration updates, facilitating seamless operation from controllers. All control panels shall utilize off-line distributed processing concepts including inter-controller communication if upgraded.

Connecting to the Ethernet through a web server hub connection or Ethernet through web

server direct connection.

WARRANTY

A. Provide 24months warranty where it starts from the date of handing over certificate in accordance with the contract conditions.

PART 2 – PRODUCTS

3. SYSTEM SOFTWARE:

Must be fully integrated software (Seamless) to manage the IP CCTV and Access Control systems as the following:

- Arm or disarm with a card read
- Record and playback access or intrusion events and alarms
- Multiple camera control, including PTZ
- Programmable camera presets
- Synchronized video playback
- Alarm video pop-up and user verification
- Synchronized video
- Define and extract video clips

The software suite shall comprise various integrated software modules that allow for the full integration and retrieval of transactions from the hardware, as well as alarm monitoring, reporting, and scheduling capabilities. The software modules shall allow editing of personnel, access levels, system configuration and reporting to be controlled by a password protected user interface. System operation for individual operators shall be possible using assigned passwords only.

The user shall have the ability to perform hardware configuration changes during or after the installation which shall include functions such as door open time, door contact time, location and reader names, and access rights configuration.

The system software shall support configuration of alarms triggering the system.
The system shall incorporate scheduled events activated by either time or a specific Programmed event, therefore being time or event triggered.
Access control functions shall include validation based on time of day, day of week, holiday scheduling, and access validation based on positive verification of card or card + PIN (Personal Identification Number).

3.1 Zone-related Software Features
3.1.1 Supervisor card unlock
3.2 Card-related Software Features
3.2.1 Time-limited access
3.2.2 PIN codes
3.2.3 Suspension of cards
3.2.4 Multiple card access
3.2.5 Card access groups
3.2.6 Time patterns (schedules)
3.2.7 Anti-pass back (APB) control
3.2.8 Reporting
3.2.9 First Card Rule (Activates the door time zone)
3.2.10 Two Card Rule-Supervisor card and regular card to allow access
3.2.11 Time zone card toggle for door locks
3.2.12 Latching mode for door locks

4. HARDWARE:

The quantities of components shall be determined and installed by the contractor based on the requirement to provide a fully operational integrated access control system as per the intent of the specification.

Communication between components i.e. gateway controller shall be RS485.
All terminals and controllers must allow for direct Firmware upgrade from the RS485 network connection. The units must be upgradeable during normal system operation, therefore should one unit be in upgrade mode all other units will continue to operate normally. The firmware shall be stored in FLASH memory on the individual units.

4.1 Door Control:

The terminals and remote use card, expire on date, first card rule, snow day rule, time zone toggle and anti-pass back with local/global capability and hard and soft Implementation.

Door Controller up to 12 doors:

A. Configurable via access control software
B. Scalable architecture ensures optimal performance with a seamless upgrade path to accommodate future growth beyond its initial installation.
C. Supervised communication and lithium battery backup ensures system reliability.
D. Large, local controller database allows access control decisions to be made by controller in real time without the need to communicate to the server.

E. Seamless support for TCP/IP protocols to allow intelligent controller(s) to tap into a LAN or any combination of 16 I/O or reader modules may be connected to the PRO32IC RS485 ports at 38,400 bps.
F. Accommodates a card database of 100,000 cards, and a transaction buffer of 50,000 transactions.
G. Option to include or exclude fields during database configuration to maximize memory usage.
H. Automatic calculation of leap-year and daylight savings

Reader:

The reader shall be fully sealed and potted electronics for use outdoors. It must include 3 bezels color including black, charcoal and ivory. It must have an integral optical tamper and security screw. The unit must be able to communicate with the proximity cards at a read range of 2 – 3”

Inputs:

Provides 14 fully configurable four-state supervised input points. System capacity must have a total of 78 inputs Outputs: Provides 8 SPDT Form C relay outputs rated at 10A @
28vdc, 8 open collector’s outputs 16ma @12vdc, 4 reader LED aux output and 4 reader buzzer output.

Lock:

Magnetic locks with 500 KG with holding force.

4.2 Cards and Database:

The card and event buffer capacity shall be 10,000 card capacity and 25,000 event capacity. The firm ware revision shall have on-board flash memory for field firmware revisions and feature expansion. Offline database backup shall be available. Export capabilities for card database, alarms, and events. The panel shall support 128 unique card formats and 8 site codes. Maximum card format size shall be 75bit suitable for handling the card format of PIV, TWIC, and FRAC cards. The time zones support will be a minimum of 127 with 128 access levels and 255 holidays.

PART 3 – EXECUTIONS

4.3 Reports and Analysis:

The system shall be capable of integrated reports, import/export of card database and alarms and events can be exported and saved in offline storage.

4.4 Embedded Web Server:

Supported browsers shall include Internet Explorer. The web browser control will allow full control monitor, view live events and manually control doors and readers. Secure Web browsing shall be SSL and SHA-1 secure socket layer encryption.

4.5 System Testing:

The Contractor shall demonstrate the functionality of the system upon completion of Installation, and shall document the result of all tests and provide these results to the Customer.

4.6 Warranty:

All equipment and systems shall be guaranteed by the Contractor for a period of one (2) year commencing with the filing date of the Notice of Completion, provided the system has been inspected and signed off by the customer. The guarantee shall cover all costs for Warranty Service, including parts, labor, prompt field service, pick-up, transportation, and delivery.

END OF SECTION

SECTION 16750
CLOSED CIRCUIT TELEVISION SYSTEM CCTV SPECIFICATIONS

PART -1 GENERAL

1.1. SECTION INCLUDES:

The contractor shall provide a closed-circuit television (CCTV) system and Accessories, complete and operable, in accordance with the following specifications, drawings, BOQs and Contract Documents (8-MP-4K) cameras for video surveillance, including design, supply, installation, and commissioning

1.2. REFERENCES:

Reference Standards: Provide systems that meet or exceed the requirements of the following publications and organizations as applicable to the work of this Section.

A. Conformity for Europe (CE).
B. Federal Communications Commission (FCC).
C. Institute of Electronic and Electrical Engineers (IEEE).
D. Phase Alternating Line (PAL).
E. Underwriters Laboratories Inc. (UL).
F. IP Code (Ingress Protection Rating) per IEC 60529.

1.3. SUBMITTALS:

A. General: Submittals shall be made in accordance with the Conditions of the Contract and Submittal Procedure Section.

B. Manufacturer's Product Data: Submit manufacturer's data sheets indicating systems and components proposed for use, including instruction manuals.

C. Shop Drawings: Submit installation drawings, including connection diagrams for interfacing equipment, list of connected equipment, and locations for major equipment components. Shop drawings shall indicate surrounding construction as provided for the Project.

D. Project Record Drawings: Indicate location of equipment and wiring on project record drawings. Submit an electronic version of the project record drawings not later than Substantial Completion of the Project.

E. Operation and Maintenance Data: Submit manufacturer's operation and maintenance data customized to the system installed. Include operator manuals.

F. Field Tests: Submit results of field testing of every device, including date, testing personnel, retesting date (if applicable), and confirmation that every device passed field testing.

G. Maintenance Service Agreement: Submit a sample copy of the manufacturer's maintenance service agreement, including cost and services for a one-year period for

Owner's review. Maintenance shall include, but not be limited to, labor and materials to repair the system, tests and adjustments, and regular inspections.

1.4. SYSTEM OVERVIEW:

A. The contractor shall supply, install, and commission IP CCTV system as one package, having the following as a minimum:

1. 8-Megapixel – 4K Cameras.
2. 4K NVRs: 4K Network Video Recorders.
3. Video Management Software.
4. VMS – Camera Licenses.
5. Recording Servers or HDs.
6. Monitoring Workstations.
7. LED SMART 4K screens.
8. Consoles and Racks with switches.

B. Surveillance IP CCTV system is required to ensure effective surveillance of an area as well as create a tamperproof record for post event analysis.

C. The System shall provide as online display of video images on video monitors / smart 4k monitors.

D. System should facilitate viewing of live and recorded images and controlling of all cameras by authorized users present in the LAN.

E. System should provide inter-operability of hardware, OS, software, networking, printing, database connectivity, reporting, and communication protocols. System expansion should be possible through off-the-shelf available hardware.

F. System shall use video signals from various types of indoor/ outdoor IP CCTV color cameras installed at different locations, process them for viewing on workstations/ monitors and simultaneously record all the cameras.

G. The recording resolution and frame rate for each camera shall be user programmable.

H. The area under surveillance shall be monitored and controlled from central/ local control room(s) through workstations.

I. Surveillance CCTV system shall operate on 230 V, 50 Hz single – phase power supply.

J. All the control equipment shall be provided in standard racks.

K. Security Room will have workstations along with controllers for camera operation. For monitoring purposes, Video monitors/ 4K monitors shall be setup with suitable mounting arrangements, as per user requirements. Facility for viewing and controlling all cameras at various other locations, as required, shall be provided.

L. Security Room shall have one or more operators simultaneously using the installed video monitors/ smart 4K LED monitors 55".

M. There must be a Control System with video control Software to manage all the video surveillance devices.

N. 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.
O. All CCTV cameras shall be motion detector type, automatically activated when motion is detected.
P. The system components shall be locked and shall be accessed only to authorized person.

1.5. QUALITY ASSURANCE:

A. Manufacturer: Minimum 6 years' experience in manufacturing and maintaining video surveillance systems. Manufacturer shall provide toll-free technical assistance and support available 24/7.

1.6. MANUFACTURER SUPPORT

A. Manufacturer shall provide customer service, pre-sales applications assistance, after-sales technical assistance, access to online technical support, and online training using Web conferencing.
B. Manufacturer shall provide 24/7 technical assistance and support by means of a toll-free telephone number at no extra charge.
C. Installer and supplier: Minimum 5 years' experience installing similar systems and shall be acceptable to the manufacturer of the video surveillance system.
D. All suppliers must have a trained staff of application engineers, who have been certified by the manufacturer in the configuration, programming and service of the management system.

1.7. EXAMINATION

A. Examine site conditions prior to installation. Notify Architect and Owner in writing if unsuitable conditions are encountered. Do not start installation until site conditions are acceptable.

1.8. INSTALLATION

A. All components of the camera system shall be thoroughly tested before shipping to the project location.
B. Camera system shall be installed, programmed, and tested in accordance with manufacturer's instructions and recommendations.
C. Coordinate interfaces with other products with Owner's representative where appropriate.
D. Provide conduit, cable, and wire for complete and reliable installation. Obtain Owner's approval for exact location of cameras, boxes, conduit, cable, and wiring runs prior to installation.

E. Install conduit, cable, and wire parallel and square with building lines, including raised floor areas. Do not exceed 40 percent fill in conduits. Gather and tie wires for orderly installation.
F. Coordinate with other trades to provide proper sequencing of installation.

1.9. FIELD COMMISSIONING AND CERTIFICATION

A. Field Commissioning: Test camera system as recommended by manufacturer, including the following:

1. Conduct complete inspection and testing of equipment, including verification of operation with connected equipment.
2. Test devices and demonstrate operational features for Owner's representative and authorities having jurisdiction, as applicable.
3. Correct deficiencies until satisfactory results are obtained.
4. Submit written copies of test results.

1.10. TRAINING

A. Conduct on-site system administrator and security / surveillance operator training in accordance with the manufacturer's instructions and recommendations. Training shall include, but not be limited to camera administration, provisioning, configuration, operation, and diagnostics.
B. Provide operation; maintenance and administration training for the proposed system to two (2) engineers. Training shall be sufficient to enable the engineers to carry out day-to-day operation, maintenance and software and hardware administration of the system without or with minimal assistance from the vendor's technical staff.

1.11. WARRANTY:

A. Manufacturer's Guarantee: Three (3) years from the manufacture date code under normal use and service for the video surveillance system.
B. The CCTV contractor shall warranty the system for 24 months after system acceptance and beneficial use by the owner.
C. Updates to the manufacturer's software shall be provided at no charge during the warranty period. For a period of 24 months' labour and parts following date when completed and placed in operation, provide full free maintenance of CCTV system, correct operational faults, and restore / replace defective / deteriorated components and finishes. And supply materials as required for proper operations and maintenance, ERY 4-MONTHS maintenance visit should be conducted and recorded. The price includes a two-year free maintenance written contract with the local agent supplier labor and parts, back to back through the contractor.

PART2: PRODUCTS

2.1 INDOOR 4K, 8-MP CAMERA (DOME) MFZ

Image Sensor	4K, 8 MP CMOS Scan
Effective Pixels	3840 (H) x 2160 (V)
Electronic Shutter Speed	Auto/Manual, 1- 1/100000s
Minimum Illumination	0.01 Lux
S/N Ratio	More than 50dB
IR Distance	Up to 40 m
IR On/Off Control	Auto, Manual
IR LEDs	Smart IR, 40 Meters
Lens Type	Motorized DC Auto Iris
Focal Length	2.7- 13.5mm; MFZ.
Focus Control	Motorized
Compression	H.265+, H.265, H.264+, H.264
Video Analytics	Intrusion, cross line, Motion detection
Advanced Analytics	Face Detection, corridor mode
Streaming Capability	3 Streams (Main Stream, Sub Stream 1, Sub Stream 2)
WDR	YES WDR(120dB)
Frame Rate	Max: 8MP (3840 × 2160) @15 fps, and supports 2688×1520 @30 fps
Bit Rate Control	CBR, VBR
Day/Night	Auto (ICR), Color, B/W
BLC Mode	BLC, HLC, DWDR
White Balance	Auto, Natural, Street Lamp, Outdoor/Manual
Gain Control	Auto/Manual
Noise Reduction	3D DNR
Motion Detection	Off / On (4 Zone, Rectangle)
Flip	0°, 90°, 180°, 270°
Mirror	Off / On
Privacy Masking	Off / On (4 Area, Rectangle)
Alarm Input	1 channel In, 1 channel Out
Ethernet	RJ-45 100Mbps
Protocols	HTTP, HTTPs, TCP, ARP, RTSP, RTP, UDP, SMTP, FTP, DHCP, DNS, DDNS, PPPOE, IPv4/v6, QoS, UPnP, NTP, Bonjour, 802.1x,Multicast, ICMP, IGMP, SNMP, ONVIF (profile S, profile G), API, ONVIF
Streaming Method	Unicast / Multicast
Max. User Access	10 Users

Recording Method	NVR, NAS (Network Attached Storage), Local PC for instant recording, MicroSD up to 128GB
Web Viewer	IE, Chrome, Firefox, Safari
Smart Phone	iPhone, iPad, Android Phone
Power Supply	PoE
Operating Conditions	-22° F - +140° F, Less than 95% RH
Weather Protection	IP67
Vandal Resistance	IK10 vandal
Casing	Metal
Certifications	CE, UL, FCC, RoHS

2.2 OUTDOOR 4K, 8-MP CAMERA (BULLET) MFZ

Image Sensor	4K, 8 MP CMOS Scan
Effective Pixels	3840 (H) x 2160 (V)
Electronic Shutter Speed	Auto/Manual, 1- 1/100000s
Minimum Illumination	0.01 Lux
S/N Ratio	More than 50dB
IR Distance	Up to 40 m
IR On/Off Control	Auto, Manual
IR LEDs	Smart IR, 40 Meters
Lens Type	Motorized DC Auto Iris
Focal Length	2.7- 13.5mm; MFZ.
Focus Control	Motorized
Bracket Range Pan	0° - 360°, Tilt: 0° - 90°, Rotation: 0° - 360°
Compression	H.265+, H.265, H.264+, H.264
Video Analytics	Intrusion, cross line, Motion detection
Advanced Analytics	Face Detection, corridor mode
Streaming Capability	3 Streams (Main Stream, Sub Stream 1, Sub Stream 2)
Frame Rate	Main Stream: 5MP (2592x1944), Max 20fps; 4MP (2560x1440), Max 25fps; 3MP (2048x1520), Max 30fps; Sub Stream: 2MP (1920x1080), Max 30fps; Third Stream: D1 (720x576), Max 30fps
WDR	YES WDR(120dB)
Bit Rate Control	CBR, VBR
Day/Night	Auto (ICR), Color, B/W
BLC Mode	BLC, HLC, DWDR
White Balance	Auto, Natural, Street Lamp, Outdoor/Manual
Gain Control	Auto/Manual
Noise Reduction	3D DNR

Motion Detection	Off / On (4 Zone, Rectangle)
Region of Interest	Off / On (4 Zone)
Flip	0°, 90°, 180°, 270°
Mirror	Off / On
Privacy Masking	Off / On (4 Area, Rectangle)
Alarm Input	1 channel In, 1 channel Out
Ethernet	RJ-45 100Mbps
Protocols	HTTP, HTTPs, TCP, ARP, RTSP, RTP, UDP, SMTP, FTP, DHCP, DNS, DDNS, PPPOE, IPv4/v6, QoS, UPnP, NTP, Bonjour, 802.1x,Multicast, ICMP, IGMP, SNMP, ONVIF (profile S, profile G), API, ONVIF
Streaming Method	Unicast / Multicast
Max. User Access	10 Users
Recording Method	NVR, NAS (Network Attached Storage), Local PC for instant recording, MicroSD up to 128GB
Web Viewer	IE, Chrome, Firefox, Safari
Smart Phone	iPhone, iPad, Android Phone
Power Supply	PoE
Weather Protection	IP67
Vandal Resistance	IK10 vandal
Casing	Metal
Certifications	CE, UL, FCC, RoHS

2.3 NVR 32-CHANNALS

Main Processor	Intel Quad-core embedded processor
Video & Audio	
IP Camera Input	32 channels
Two-way Talk	1channel Input, 1channel Output, RCA
Display	
Interface	2 HDMI (one up to 3840x2160), 1 VGA
Resolution	12MP/8MP/6MP/5MP/4MP/3MP/1080p/960p/720p/D1/2CIF/CIF
Multi-screen Display	The 1st screen: 1/4/8/9/16/25/36 The 2nd screen: 1/4/8/9/16
OSD	Camera title, Time, Video loss, Camera lock, Motion detection, Recording
Recording	
Compression	H.265/H.264/MJPEG
Resolution	12MP, 8MP, 6MP, 5MP, 4MP, 3MP, 1080P, 720P, D1
Record Rate	320Mbps

Record Mode	Manual, Schedule (Regular (Continuous), MD(Video detection: Motion detection, Camera blank, Video loss), Alarm), Stop, Smart Detect (Intrusion, Abandoned/Missing Object, Scene Change, Face Detection, People Counting)
Video Detection & Alarm	
Trigger Events	Recording, PTZ, Tour, Alarm out, Video Push, Email, FTP, Snapshot, Buzzer & Screen tips
Video Detection	Motion Detection, Video Loss & Camera Blank
Alarm Input	16 Channels, low level effective, green terminal interface
Relay Output	4 Channels, NO/NC Programmable, Green Terminal Interface
Playback & Backup	
Search Mode	Time/Date, Alarm, MD & Exact search (accurate to second)
Playback Function	Play, Pause, Stop, Rewind, Fast play, Slow play, Next file, Previous file, Next camera, Previous camera, Full screen, Repeat, Shuffle, Backup selection, Digital zoom
Backup Mode	USB Flash Drive, Network, External USB DVD burner
Network	
Interface	2 RJ-45 ports (10/100/1000Mbps)
Ethernet Port	2 Ethernet ports can be configured for teaming or independent port use
Network Function (protocols)	HTTP, TCP/IP, IPv4/IPv6, UPnP, RTSP, UDP, SMTP, NTP, DHCP, DNS, IP Filter, PPPoE, DDNS, FTP, Alarm Server, IP Search ONVIF
Max. User Access	10 users
Smart Phone	iPhone, iPad, Android
Storage	
Internal HDD	8 SATA ports, each equipped with 10TB each, WD Purple
HDD Mode	Raid 0/1/5/6/10
Auxiliary Interface	
Front cover	Flip down cover with hot swap bays
USB	4 USB ports (2 USB2.0, 2 USB3.0)
E SATA	1 eSATA port for eSATA expander
SAS	1 Mini SAS port
RS232	1 port, For PC communication& keyboard
RS485	1 port, For PTZ control
Power Supply	AC100V-240V, 50-60Hz
Certifications	CE, UL, FCC, RoHS

2.4 SWITCHS

A. Active Components (Switches) must be provided as the required specifications in the Document.
B. Approved manufacturing list for the Switches:
C. Number of patch panels/cabinet, Number of cabinets/ Floor, and number of switches will be depending on number of Data Points for cameras /floor, the copper cat6A patch cords (1-m and 3-m per Data point for camera) must be provided and plugged right in each cabinet.
D. All cabinets are connected to UPS power supply only.
E. All installation work shall be as per Data Transmission rules and regulations. Where no regulation is available, IEE wiring regulation shall be followed.
F. The maximum horizontal portion of a cabling system from work area information outlet to a mechanical termination at the patch-panel in the wiring closets must not be more than 90 meters, the cable run must be free of ridges, taps & splices. Cabling shall be as per ISO /IEC IS11801 Standards.
G. Cables shall be of one continuous length. No joints are to be introduced in any circuit starting from work area outlet to a mechanical termination at the patch panels in the wiring closets.
H. Drawing and specification are complementary each to the other.
I. Comply with the below Specifications:

Model	Enterprise business model
Needed Ports	24 x 1G Base-TX, RJ-45 Port. 2 x 1G SFP ports (not shared ports) console port with console cable
Switch Throughput	35 MPs
Switch Capacity	52 Gaps
MAC Table Size	8K
Power Supply	POE+ (Power Over Ethernet)
Port security	802.1x
VLANs	Provide up to 4,000 VLAN IDs
Remote Access Protocols	HTTP, Telnet, SSH
Supported Protocols	Simple Network Management Protocol (SNMPv1/v2/v3) Link Layer Discovery Protocol (LLDP)
Architecture	Non-blocking architecture

2.5 24U Rack Cabinets and 12U Rack

1. Free stand, smart rack
2. Min. 2 Fans for 12U AND 4 fans for 24U
3. Front Glass Door with Lock
4. Power Strip (Minimum 6 Outlets)
5. Lockable, Removable Side Panels
6. One Shelf
7. CERTIFICATIONS: CE, FCC, RoHS
8. The Cabinet Must Be Supplied with All Its Accessories
9. FANS SPECIFICTIONS: Min. 2 Fans for 12U, AND 4 fans for 24U
   A. 1U or 2U Rack Mountable Digital Thermostatically Controlled Quiet Fan Tray unit, for use in 19" equipment racks. To be fitted at the top of the rack to move hot air up through the rack as required.
   B. Fan run LED indicator.
   C. Over temperature alarm.
   D. Temperature Sensor Input Socket DC in/out sockets
   E. Low noise - Quiet functioning: 35-45dBA.
   F. Airflow for each fan: 30 m3 / hour.
   G. Continuous temperature monitoring fan control.
   H. Operating range from -5 to +45 degrees Celsius.
   I. Service lifetime: 45,000 hrs.
   J. 230V connection.
   K. Electrical power: 20-30 W.
   L. Thermal switch
   M. Certifications: CE, UL, FCC, RoHS

2.5 CAT6A Patch

Patch Panel specifications

1 24 Ports, 1U Height
2 RJ-45 Jack Connector Interface:
   a. Cat- 6A Compliant
   b. Two Piece, Easy to Use Design
   c. Multi use if needed
   d. Tool-Less Termination
   e. Suitable For Patch Panel and Faceplate Mounting
3 Complies With CAT 6A Standards
4 Must Be Provided with All Its Connectors and Accessories

5 Compatible With the Provided Cabling System
6 All Ports Must Be Clearly Labeled

2.6 LED SMART 4K screens

A. Panel	1. Type :	55" LED Panel
	2. Native resolution :	3840 x 2160 4K UHD
	3. Panel / Pixel pitch :	8 Bit / H/V 0.315 mm
	4. Coating :	Antiglare Surface Haze 3%
	5. Backlight :	Direct LED
	6. Viewing angle H / V:	178° / 178°
	7. Contrast (typ) :	1300:1(typ)
	8. Brightness:	600 cd/m2
	9. Response time :	8 ms
	10. Operating System	OS: Android 10.0 or higher
B. COMPATIBILITY	RGB PC/HDMI PC: Up to 1920x1080@60Hz. HDMI: 480i, 480p, 720p, 1080i, 1080p, 4K2K@60Hz DVI: 480i, 480p, 720p, 1080i, 1080p Android Version: Android 8.0	
C. Input	Power AC, VGA, HDMI x2, DVI-D, RJ45, USB Type A x2, PC Audio In (3.5 mm), RS232, Micro SD card, IR in	
D. Output	Line out (3.5mm), RS232 out, IR out.	
E. Software	Supported OS: Win XP 32 bit, Win Vista 32/64 bit SP2, Windows 7 32/64 bit	
F. OSD control on backside	OSD-button and 1 Standby-button	
G. Features	1. Image Setting, Source / Volume Control, Sharpness Enhancement, 10 Bit	
	2. Control, RTC Function, FW Update (USB / OTA), Device Management	
	3. Solution (DMS), WPS (office viewer App), X-Sign, Instashame	
H. Connectivity	WIFI: 2.4G/5G LAN: 10/100Mbps	
I. Mounting	400 x 400 mm	
J. Mounting direction	Landscape	

K.	Operating hour per day	1. MTBF: 50000hrs 2. Operation Hours:24Hour/7days (24 /7)
L.	Voltage for operation :	100 ~ 240 VAC ; 50 - 60 Hz
M.	Standard Certification:	CE, Energy Star, TUV, UL,

END OF SECTION

SECTION 87113
Automatic Door Operators &
Gate Barrier System

1.03 QUALITY ASSURANCE

A. Automatic door operators, controls and other equipment shall be products of a manufacturer regularly engaged in manufacturing such equipment for a minimum of 5 years.

B. One type of automatic door equipment shall be used throughout the building.

C. Equipment installer shall have specialized experience and shall be approved by the manufacturer.

1.04 WARRANTY

A. Automatic door operators shall be subject to the terms of the "Warranty of Construction", that the Warranty period shall be 24 MONTHS.

2.1 SLIDING GATES MOTOR:

SPECIFICATION

Power Supply	230 V – 50/60 Hz
Power (W)	< 500
Speed	0.16 m/s
Force	800 Nm
Work Cycle	>16 Cycle/Hour
Protection Level	IP 44
Working Temperature	-20 to +50 C

- For sliding gates weighing up to 1500 kg.
- Control unit with receiver compatible with encoding O-Code, Smilo, FloR and Flo. Reliable and safe, with electronic clutch and safety anti-crushing protection.
- maximum protection of electronics against external disturbance with opto-isolated circuits.
- easy and quick installation: external mounting, sturdy and practical plate
- sturdy and easy to use die-cast aluminum key-operated unlock system.
- prolonged lifetime and silent operations.
- cooled engine for increased work intensity.
- built-in electronics with removable plugs.
- self-braking drive, which means that the gate locks mechanically after stopping the engine. As a result, there is no need for additional mechanical locking of the gate using the lock, nor is it possible to open it manually.
- equipped with a mechanical system that allows the gate to be opened and closed in manual mode in the event of a power failure or malfunction of the door.
- smooth release function during closing and soft start - it consists in reducing the speed so as to avoid a strong jerk when opening or closing the gate.
- an electronic brake that reduces the inertia of the wing upon completion of movement

- The motor package shall be guaranteed for at least 2 years.
- The motor package shall include:

  - Motor with control unit (1x)
  - Remote Control Gate Opener (2x)
  - Flashing LED signal light (1x)
  - Surface mounted universal Photocells (1x)
  - Automatic Door Sign (1x)
  - Steel Rack 30x8 mm. (4x Meter)
  - Metal Mounting Brackets

2.2 SLIDING DOOR OPERATOR:

SPECIFICATION

Double panel doors passage width	800 – 3000 mm
Panel weight (max)	2x160 kg
Passage height	2100 – 3200 mm
Power Supply	230 V – 50/60 Hz
Power (W)	< 200
Hold-open time	0.5 – 30 seconds
Opening and closing Force (max)	150 Nm
Opening speed (incremental setting)	10 – 50 cm/s
Closing speed (incremental setting)	10 – 40 cm/s
Protection Level	IP 20
Working Temperature	-20 to +50 C

** The Sliding Door Operator shall have the following:

- Modular designed & all-purpose sliding door opener
- Universal parts and hardware
- Running automatically, quietly, and smoothly (Off, Automatic, Permanent open, Partial open, Exit only)
- Up to 3.0-meter opening width, single sliding or double sliding door
- Microprocessor controls sliding speed and other special functions programmable.
- Modular design, easy for mounting, service, and maintenance.
- Custom build feasibility according to customer requirement
- Standardized mechanical components for all operators, including driving and controlling module.
- Optional battery pack for emergency escape route solution
- The package shall include:

  - 30V motor x 1
  - controller (Basic module) x 1
  - Universal switching power supply (90-230v) x 1
  - Carriage (sliding door hang wheel) x 4
  - 5 positions program switch x 1
  - Belt connection x 2
  - Return pulley (With belt tension) x 1

- End stop (End buffer) x 2
- Microwave radar sensor x 2
- Driving toothed belt (6m/8m/10m) x 1
- Rail profile (4.15m/5m/6m) x 1
- Cover (Aluminum, 150mm/100mm)
- Safety beam sensor (Light barrier)
- Electric mechanical lock
- Backup battery pack (Rechargeable)
- Magnetic lock
- Dual mode sensor (Radar plus IR)

2.3 GARAGE SHUTTER DOOR MOTOR:

SPECIFICATION

Power Supply	230 V – 50/60 Hz
Power (W)	< 1300
Speed	12 rpm
Force	300 Nm
Continuous operating time	5 min
Protection Level	IP 44
Working Temperature	-20 to +50 C

- For shutter doors weighing up to 400 kg.
- The tubular motor shall be ideal for large roller shutters gates.
- shall have a mechanical limit switch and an emergency operation mechanism.
- Reliable thanks to the manual emergency operation mechanism.
- The actuator guarantees the operation of the roller shutter even in the event of a power failure.
- The manual drive activates automatically when the crank is used.
- The motor is safe to devices such as the protection against falling down the gate or the end protective bar.

2.4 WINDOWS SHUTTER MOTOR:

SPECIFICATION

Power Supply	230 V – 50/60 Hz
Power (W)	< 150
Speed	17 rpm
Force	20 Nm
Continuous operating time	4 min
Protection Level	IP 44
Working Temperature	-10 to +40 C
Noise Level	< 50 db

- shall have a mechanical limit switch.
- The actuator guarantees the operation of the roller shutter even in the event of a power failure.
- The manual drive activates automatically when the crank is used.

2.5 GATE BARRIER:

SPECIFICATION

1.	Arm length (3-4) m with LED indication light.	
2.	Open / close time (3-6) s.	
3.	White-paint finished aluminum bar.	
4.	Rubber impact protection strip.	
5.	Red adhesive reflector strips	
6.	Indicator lights for click fixture on upper or lower side of bar.	
7.	Ambient Temperature range (-10 °C to +55 °C)	
8.	Power Requirement: 230 V ± 10%, 50 HZ.	
9.	Frequency use: (high-super intensive use car park), designed for heavy traffic applications.	
10.	Daily Operating cycles (opening /closing-24/7 non-stop): 5000 cycles, commercial type.	
11.	Drive Unit: 100 percent (100%) duty cycle, spring-balanced, **brushless**, DC motor and lever system. In case of power outage, the barrier can easily be moved by hand.	
12.	Controller: MGC integrated **24** or **36V** DC controller, Easy to program lane configurations and operation parameters via push buttons and LCD display.	
13.	At least two remote controls to open/close the gate.	
14.	Safety Device: Provide with the following:	
	a.	Photo-electric beams.
	b.	Single-beam safety light barrier consists of a transmitter and a receiver.
	c.	Light barrier is specifically designed for outdoor use with integrated heating, to ensure proper function even under the most severe of weather conditions.
	d.	Safety Loop Detector.
	e.	Movement detectors before the gate to open once a car want to exit the building.
15.	**Features:**	
	a.	Low power consumption, heavy duty, commercial type.
	b.	Direct drive operation with modular construction.
	c.	Built-in position sensors with no limit switches providing arm position status and self-learning control to optimum braking and eliminate boom arm bouncing, sagging or rotating out of position.
	d.	**IP 54** rated enclosure.

	e.	Harsh outdoor environments.
	f.	Corrosion resistant steel cabinet, powder coated robust steel.
16.	All prices include the installation, testing, connecting the system to the security desk and commissioning for the system.	
17.	The system complies with CE European certifications: Resistance to wind load, Electrical safety, Radio spectrum.	
18.	Warranty: 24 months.	
	19. Please note that the gate barrier system must include a “remote reader” that operates at a distance of (6) meters through a chip on the front car glass, and a letter of approval from the telecommunication regulatory commission of Jordan must be attached to the frequency that will be used**.**	

END OF SECTION

SECTION 16800
Photovoltaic System

PART 1 GENERAL

1.1 INTRODUCTION

A. This section aims at providing the contractor with enough information on the photovoltaic system to allow for providing all documents regarding the design, supply, and installation of a fully operational PV system.

B. The design aims at utilizing renewable energy and implementing energy efficient measures through installing a photovoltaic system to reduce the electricity bill and minimum carbon emissions at the Social Security Corporation Branch.

C. The utility is served by one 3- ph low voltage main distribution board.

D. It is the responsibility of the contractor to connection with MDB's, taking into consideration the MDB's compatibility and EDCO's approvals.

1.2 REFERENCES

1. The proposed system shall comply with the relevant laws and regulations issued by the ministry of energy and mineral resources (MEMR).
2. Electricity Regulatory Commission (ERC), and in line with the requirements of the Electric Company (EDCO).
3. The design shall be based upon meeting Industry Standards.
4. The National Electric Code.
5. IEEE standard for interconnecting distributed resources with electric power systems and other applicable codes and standards.

1.3 SUBMITTALS

1. Shop Drawings: Indicate system wiring diagram showing each device and wiring connection.
2. Product Data: Submit catalogue data showing electrical characteristics and connection requirements.

1.4 CLOSEOUT SUBMITTALS

1. Project Record Documents: Record actual locations of PV equipment.
2. Operation and Maintenance Data: Submit manufacturer's standard operating and maintenance instructions.

PART 2: QUALIFICATIONS & MAINTENANCE

2.1 MAINTENANCE SERVICE

1. The contractor shall include clear trouble-shooting way and contact information that the client can use in case of emergencies.
2. The contractor shall include a detailed maintenance plan including a maintenance checklist and technical support.
3. The contractor shall include a detailed cleaning mechanism for the PV System "DETAILED cleaning schedule services NOT LESS THAN 12 VISITS /YEAR".

PART 3: TECHNICAL REQUIREMENTS

3.1 GRID-CONNECTED PV SYSTEM COMPONENT SPECIFICATIONS

The contractor shall include but is not limited to the specifications of the following equipment and materials:

3.1.1 PV MODULES

The photovoltaic modules must fulfil the following technical specifications and standards, which have to be certified by an official institute if applicable.

1.1. The output power of the crystalline module should not be less than 550 Wp at standard test condition (STC).

1.2. The photovoltaic modules shall be monocrystalline PV technology, thin-film and polycrystalline modules are excluded.

1.3. Only one supplier and one module type (one power class) are acceptable.

1.4. The Photovoltaic modules should be manufactured before 6 months from the date of delivery on site.

1.5. Glass thickness: Total module glass thickness should not be less than 3.2mm.

1.6. Module Frame: Should be made of anodized Aluminum and assembled with interlocking corners keys, and should not contain any screwed or mitered connections.

1.7. Cell Spacing: Modules should have a safety distance of not less than 2cm between the last row of cells and the frame to reduce the effect of dust accumulation at the bottom of the module.

1.8. Junction Box: Integrated 3-4 bypass diodes, shall be fully immersed in Silicon and shall be IP65.

1.9. Modules temperature sensitivity at peak power should not exceed -0.36%/°C.

1.10. The PV modules frame should be made from Anodized Aluminum.

1.11. The PV modules maximum system voltage should not be less than 1000V.

1.12. The PV module string connectors shall be same manufacturer as used by the module manufacturer.

1.13. The PV modules should be PID resistant.

1.14. The PV modules should have a positive power tolerance and measurement uncertainty of +/-3%.

1.15. The PV modules' aluminum frame must not directly contact any dissimilar metal.

1.16. Electrical connection shall be on a robust terminal block in an IP67 junction box or higher.

1.17. Module Cable: Should not have a length of less than 100cm, and should be standard-equipped with MC4 connectors.

1.18. Module Serial Number: All modules should have their serial number on the module.

1.19. Operating Temperature Range: -10°C to +85°C.

1.20. Maximum System Voltage: Should not exceed 1,000V.

1.21. Maximum Reverse Current: Should be at least 25A.

1.22. Power Sorting: Should be Positive, -0 Wp to +5 Wp over nominal power P max.

1.23. Module Warranties:

1.24. 10-year product warranty, documentations should be supplied from manufacturer by the contractor.

1.25. Linear 25-year performance warranty: The actual power should be at least 97% of the nominal power in the first year; it falls by no more than 0.7% annually beginning in the second year, with power of at least 80% guaranteed after 25 years. The warranty must state that the malfunctioning solar photovoltaic module must be exchanged by the manufacturer. The replacement solar module must be identical to, or an improvement upon, the original design of the malfunctioning solar module.

1.26. Modules should comply with the following certifications and approvals:

1.27. DIN EN / IEC 61215: PV module design and type approval qualification standard

1.28. DIN EN 61730: PV module safety qualification for safety class II.

1.29. DIN EN 60068-2-60: Ammonia resistance (very well suited for use in agricultural operations).

1.30. IEC 60068-2-68: Dust resistance (very well suited for use in dusty areas near deserts).

1.31. Module manufacturer should comply with the following certifications and approvals:

1.32. ISO 9001: Quality management system.

1.33. Along with TUV, CE compliant and UL certification, salt mist / ammonia resistance should be provided.

1.34. Terrestrial photovoltaic (PV) modules.

1.35. Mechanical load tests up to 5400 Pa, Damp Heat, Thermo Cycle and Humidity and Freeze tests.

1.36. Flash reports of PV modules (SN, Voc, Ipmax) shall be provided.

1.37. With the PV plant in operation and in the absence of shades, the PV modules must not exhibit hot spots or hot cells

3.1.2 INVERTERS

1.1. ENA Standards: Inverters must comply with ENA's G99 certificates.

1.2. Maximum DC Input Voltage: Should not exceed 1,000V.

1.3. No. of MPPTs: Should have at least two independent MPP trackers, and it should be possible to connect asymmetrical strings at the different MPP trackers of the same inverter.

1.4. Wide MPPT Voltage Range: The difference between the minimum and maximum MPP Voltage limits should be at least 400V.

1.5. Rated AC Power Frequency: 50Hz.

1.6. Maximum Efficiency: Should not be less than 98%.

1.7. European Efficiency: Should not be less than 97%.

1.8. Topology: Should be only Transformer less.

1.9. Cooling Mechanism: Opti Cool Technology.

1.10. Integrated DC Switch: Inverters should have their own integrated DC switch, and it must be resistant against DC electric arcs.

1.11. Adjustable Power Factor: Inverter should have the capability of having an adjustable power factor from 0.8 overexcited to 0.8 under excited.

1.12. Total Harmonic Distortion: Should not exceed 3%.

1.13. IP Protection Grade: Should be at least IP65 FOR THE outdoor and garage indoor

1.14. Multifunction Relay: Should be easily integrated into inverters.

1.15. Should have the following safety measures:

a. Grid Monitoring

b. Ground Fault Monitoring

c. DC Reverse Polarity Protection

d. AC Short-Circuit Current Capability

e. All-Pole Sensitive Residual Current Monitoring Unit

f. Electronic String Fuse Failure Detection

g. Type III Overvoltage Protection (Standard overvoltage protection)

h. Type II Overvoltage Protection (Should be easily integrated into the inverters)

1.16. Warranty: Should be at least 10 years lifetime, documentations should be supplied from manufacturer by the contractor

1.17. Monitoring System: Should have an interface that is easily readable.

1.18. The inverter shall have surge protection SPD on the DC and AC side. If the inverter does not support integrated SPD protection, a separate external SPD must be installed.

1.19. The inverter must be installed on a separate hot-dip galvanized steel mounting structure i.e., separate from the PV mounting structure and must be protected from direct sun light and rain (weather conditions).

1.20. The AC power of the inverter must synchronize automatically with the AC voltage and frequency of the grid (3-phase) within the tolerance range specified according to the British Energy Networks Association (ENA's) engineering recommendations (G99).

1.21. The inverter(s) shall comply with the EMRC and the DISCO's regulations and standards.

1.22. The Inverter shall have the following protections: reverse current, input over voltage & over current via fuses.

1.23. Temperature operating range: -20 ºC to 60 ºC.

1.24. The allowable size of the inverters used in this project must not exceed 25 kW ac for each.

3.1.3 PV DC Cables

The DC cables (main and string) shall be selected and mounted in a way to withstand the external influences on site, such as temperature, UV irradiation, wind, sand, and mechanical loads.

The minimum specifications are:

1.1. Nominal Voltage: 1,800V.

1.2. Conductor Type: Tinned fine copper strands.

1.3. Operating Temperature Range: -20°C to +110°C.

1.4. Double Insulation.

1.5. MC4 connectors should be used to connect different cable extensions together.

1.6. PV Cables should be marked properly by means of good quality labels or by other means so that cable can be easily identified.

1.7. PV Cables should be fixed to mounting structure by means of UV-resistant cable ties.

1.8. Warranty: Should be at least 20 years, documentations should be supplied from manufacturer by the contractor

1.9. PV cables should comply with the following certifications and approvals:

1.10. All DC cables shall be copper, single-core cables and double insulated, Aluminum conductor is not allowed.

1.11. DC main cables shall be underground buried in suitable electrical conduits where needed.

1.12. DC wires from the connection box to the inverter input must be undergrounded inside PVC conduits where needed.

1.13. For string cabling the type PV1-F or similar shall be used.

1.14. Circuit shall be installed as close as possible in parallel to avoid induction loops.

1.15. DC cables shall be UV resistant, flame retardant, and with low smoke characteristics.

1.16. DC cables shall comply with local and international standards and DISCO's requirement.

1.17. The cables shall not be installed in direct sunlight. Between individual mounting structures, for example, a tube shall be used for protection. All external cables must be installed inside a cable basket PVC Flexible pipe with glands shall be used between the modules and the cable basket or hot dipped galvanized cable tray with minimum thickness of 1.5 mm and minimum galvanization thickness of 30 µm.

1.18. The cable ties shall be UV resistance.

1.19. The cable clips shall be used for managing cable under PV modules.

1.20. All cables shall be marked properly by means of permanently labels at both ends so that cable can be easily identified.

1.21. All cables must be fixed. The cables shall not bear any mechanical load on their terminations (strain relief) under any circumstance. Cable straps are not sufficient for the purpose of strain relief.

1.22. The contractor shall use red DC cable for positive side and black cable for the negative side.

1.23. The label shall provide information about the corresponding inverter, combiner box and string number.

1.24. All cables shall be marked in compliance with IEC 60446-3 category C Basic and safety principles for man-machine interface, marking and identification.

1.25. PV DC connectors for string interconnection shall be of the same brand and type as used by the PV

1.26. Module manufacturer. Connectors of different brands must never be used in the same connection (male female).

1.27. It is not allowed to cut the original connectors of the PV module.

3.1.4 AC and Control Cables

A. AC cables and control cables shall be Copper, XLPE insulated and armored sheathed cables with rated voltage of 0.6/1kV. These cables shall be UV resistant and flame retardant in case they are not buried.

B. All cables shall be marked in compliance with IEC 60446-3 category C Basic and safety principles for man-machine interface, marking and identification.

C. AC cables shall comply with local and international standards and DISCO's requirements.

D. All external cables must be installed inside an external **hot dipped galvanized cable tray** with minimum thickness of **1.5 mm** and minimum galvanization thickness of 30 µm.

E. All cables laying in trenches must be separated by cable spacers.

F. Reference codes and standards for All cables:

1. IEC 60189-2 Low-frequency cables and wires with PVC insulation and PVC sheath – Part 2: Cables in pairs, triples, quads, and quintuples for inside installations.
2. IEC 60228 Conductors of insulated cables.
3. IEC 60502-1 Power cables with extruded insulation and their accessories – Part 1: Cables for rated voltages of 1 kV ((Um = 1, 2 kV) and 3 kV (Um = 3, 6 kV).
4. IEC 60502-2 specifies the construction, dimensions, and test requirements of power cables with extruded solid insulation from 6 kV (Um=7.2kV) up to 30 kV (Um=36kV) for fixed installations such as distribution networks Reference codes and standards for cable testing:

5. IEC 60885 Electrical test methods for electric cables
6. IEC 60332 Tests on electric and optical fiber cables under fire conditions.

3.1.5 AC Distribution Boards

A. The Distribution Boxes shall be made of hot coated or galvanized steel; dust and vermin proof with a protection degree IP66 at least.

B. The terminals and bus bars shall be made of tin coated copper and appropriately sized; the boxes shall have suitable cable entry with suitable glands arrangement for both input and output cables.

C. Suitable markings on the bus bars shall be provided to identify the bus bars.

D. The distribution box shall be grounded and for this purpose a suitable ground terminal is to be arranged.

E. The distribution boards shall be completely factory assembled, pre-wired, and tested.

F. All distribution boards must be equipped with an appropriate SPD device.

G. The distribution boards shall be designed to meet the requirements of

H. The contractor shall provide a set of installation manual/user manual for the system, the manual includes complete system details such as inverters details, working principles, etc. step by step maintenance and troubleshooting procedures are included in the manual.

3.1.6 MONITORING SYSTEM:

Supervisory Control and Data Acquisition (SCADA)

1. Contractor shall supply and install an Owner-approved monitoring hardware and software package, including interconnection communications. SCADA pricing should include hardware and software (including all software subscriptions). The monitoring system shall provide energy generation data, historical data, and meteorological data. The system shall be configured to sample data at a rate of once per second, with 1to10-minute average intervals, and shall be configured to update the server at least once every 15 minutes. The system shall be configured to sample and store the 1to10-minute averaged interval data for a period of 24 months.
2. The monitoring system shall be capable of issuing alarms and notices to instantly alert the system manager to potential system problems.
3. The metering scheme shall be capable of reading the net electrical energy to the grid during daylight hours and the nighttime auxiliary loads when the Plant is in standby mode.
4. Data from the monitoring system can be accessed through the system’s dashboard, which allows for public and administrator panel views.

5. Contractor shall test the installed communications system to demonstrate its ability to meet the requirements of its intended use. Testing shall be done when the final system interconnections have been made.
6. Contractor shall furnish and install all materials and equipment necessary to complete the SCADA installation. The monitoring system shall be configured for reporting of generation statistics.
7. Points to be monitored by the SCADA system shall include, at a minimum:
    - Meteorological station
    - Monitor and record all data of Meteorological Stations
    - Inverters
    - AC voltage
    - DC voltage
    - AC current
    - DC current
    - Kilowatts (kW)
    - Kilowatt hours (kWh)
    - Metering
    - Monitor and store date from the Plant meter.
    - Transformers
    - Plant switchgear
8. The following shall make up the SCADA calculated and reported values list:
    - Model versus actual performance in kW and kWh
    - Day's energy in kWh
    - Month's energy in kWh
    - Year to date energy in kWh
    - Total lifetime energy in kWh
    - Plant performance ratio, current value
    - Plant performance ratio, day's average
    - Plant performance ratio, month's average
    - Plant performance ratio, year to date average
    - Plant performance ratio, since commissioning

9. All monitored plant electrical generation equipment (e.g., inverters, transformers, switchgear) shall be monitored to capture real time AC and DC electrical characteristics, including:
    - Voltage
    - Current
    - Power
    - Frequency
    - Power factor

10. All monitored plant electrical generation equipment (e.g., inverters, Meter) shall be monitored to capture all diagnostic information, including:
    - Temperatures
    - Alarms
    - Status indicators
    - Fault states

11. Points to be Controlled by the SCADA system shall include, at a minimum:
    - Generated Reactive Power Control.
    - Power Factor Set point.
    - On/OFF Inverter
12. The SCADA system must be send the events and the alarms to specified E-mails.

PART 4: TESTING

Provide the service of a factory-trained engineer or technician authorized by the manufacturer of the PV system to technically supervise and participate during all the adjustments and testing of the system.

Component	Minimum requirement
PV Module	
PV module manufacture	-
PV module manufactured	≤ 6 months
Cell type	Half-cut monocrystalline
Module nominal STC power (W_p)	≥ 550
Module warranty (years)	10
10 year power loss guarantee	≤10%
25 year power loss guarantee	≤20%
LID loss percentage including first year degradation	≤3%
Modules temperature sensitivity at peak power	≤ 0.36%/°C
Module Efficiency	-
PID Resistance	Yes
Quantity of modules	-
Third party bankruptcy insurance	Yes
Flash reports of PV	Yes
Operating PV temperature ranges between -10 °C & + 85 °C	Yes
Module power tolerance	≥0
PV junction box IP rating	IP67
PV module compliance with standard	IEC 61215
PV module compliance with standard	IEC 61730
PV module compliance with standard	IEC 60068-2-68
TUV, CE compliant and UL certification	Yes
PV module frame made from anodized aluminum	Yes
Compliance with all requirements in the RFP	Yes
Inverters	Yes
Inverter manufacturer	-
Inverter model	-
Inverter nominal power output (kW)	25 kW
Inverter maximum power output (kVA)	-
Number of inverters	Not less than 7 Nos

Number of MPPT	-
Warranty (years and lifetime)	10
Temperature operating range	-20 ºC to 60 ºC
Harmonic distortion	≤3%
Inverter euro efficiency (%)	≥98
Cooling type	-
SPD protection	DC and AC
Over current protection	DC and AC
Installation method	Indoor or outdoor
IP protection	IP65 if without housing
ENA Certificate	G99
UV, CE compliant and UL certification	Yes
Comply with EMRC and DISCO regulations and standards	Yes
Compliance with all requirements in RFP	Yes
AC Distribution boards	
Manufacturer	-
IP protection	IP 66
Warranty (years)	2
Appropriate sizes for terminals and bus bars	Yes
Bus bars material	Tin-coated copper
The distribution boards shall be completely factory assembled, pre-wired, and tested.	Yes
SPD protection	Yes
Compliance with all requirements in the RFP	
PV Cables, Connectors and Accessories	Yes
Manufacturer	-
Material	Copper
Type	-
Cross section (mm^2)	≥4
Warranty (years)	20
TUV certificate	yes

Operation temperature	≥+90 °C
UV resistant, flame retardant	Yes
Installation method	-In PVC pipe under ground -In hot-dip galvanized cable tray above ground or cable basket
Cable tray thickness	≥1.5 mm
Cable tray/basket galvanization thickness	≥ 30 µm
Cable clips	Yes
DC connectors	same brand and type as used by the PV module manufacturer
Cable color	Red for + Black for -
Compliance with all requirements in the RFP	Yes
AC Cables	
Manufacturer	-
Cross section (mm^2)	-
Material	Copper
Insulation type	XLPE
Warranty (years)	2
TUV certificate	Yes
Armor	Yes, if underground
Trench cable laying	Using cable spacers
Cable tray thickness	≥1.5 mm
Cable tray/basket galvanization thickness	≥ 30 µm
Compliance with all requirements in the RFP	
SCADA	Yes
Manufacturer	-
Warranty (years)	2
Power backup	USING BUILDING UPS
Data transmission (including subscription for 2 years)	Internet and GSM

24/7 remote access with 55" 4k screen 24/7 50000h life- time	Yes
Full remote control and monitoring	Yes
Compliance with all DISCO requirements	Yes
Compliance with all requirements in the RFP	
Labelling	Yes
Nameplate for all equipment	Steel
Tags for DC and AC power cable or wires from both ends and in each manhole	Yes
Cable ties	UV resistant
Warning labels	Yes
Weather and UV resistance	Yes
Compliance with all requirements in the RFP	
Lightening Protection	Yes, using the building lightning protection system.
Cleaning Water Distribution System	Yes, 12 times / year
Maintenance and Cleaning	Yes
maintenance & cleaning period	2 years
Water distribution system	Yes
Meet the requirements mentioned in the RFP	Yes

Including but not limited to the following items Breakdown.

Component	
DC section	PV Modules.
	DC Cables.
	DC Combiner Box.
	DC installation.
	Mc4 connectors.
	Earthing system.
AC section	Inverters.
	Inverter mounting structure, canopy and fencing.
	AC-LV Cables.
	AC-LV installation.
	Distribution boards including circuit breakers.
	Power and Energy meter.
	Distribution boards.
	G99 relay with motorized circuit breaker.
	Earthing system.
Accessories	Cable trays, conduits, cable ties, clips, lugs, glands, labelling and marking etc.
Tests and studies	License and approvals.
	Material Test.
	3rd party testing and commissioning.
Project	EDCO application fees.
development	EDCO GIS fees.
	Engineering, design and management .
	Water drainage system.
Miscellaneous	2 years O&M and cleaning.
	Cleaning and water distribution system.
	Meteorological Sensors.
	Lightening protection system.
	SCADA System with a 55” 4k screens.
	Training.
	Communication hardware (routers, switches, etc.) using the SSC network.
	Others (if any).

The supplier/contractor should include in his proposal a visit to the factory of which the supplier is providing his offer from for two electrical engineers from the owner side and one engineer from the consultant’s side to conduct the technical meetings and witness the factory acceptance tests and inspect the lifts assembling and materials in accordance to project master bid documents, please note that all expenses are covered under the EPC contract.

END OF SECTION

SECTION – 16710
COMPUTER NETWORK SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Data Switches, Patch Panels, Fiber Cables, Giga-Speed UTP Cables, Data Outlets and Cabinets.

1.2 REFERENCES

A. EIA/TIA 568 (Electronic Industries Association/Telecommunications Industries Association) - Commercial Building Telecommunication Wiring Standard.
B. EIA/TIA 569 (Electronic Industries Association/Telecommunications Industries Association)- Commercial Building Standard for Telecommunications Pathways and Spaces.
C. NETA ATS (International Electrical Testing Association) - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SYSTEM DESCRIPTION

A. Backbone Pathway: Conform to EIA/TIA 569 using conduit and sleeves
B. Horizontal Pathway: Conform to EIA/TIA 569, using trunks.
C. Horizontal Wiring: By Owner. Complete from Branch switch to each outlet using unshielded twisted pair horizontal cables.

1.4 SUBMITTALS

A. Section : Submittal Procedures: Submittal procedures.
B. Product Data: Submit catalog data for each termination device, cable, and outlet device.
C. Test Reports: Indicate procedures and results for specified field testing and inspection.

1.5 CLOSEOUT SUBMITTALS

A. Section : Execution Requirements: Closeout procedures.
B. Project Record Documents: Record actual locations and sizes of 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 documented experience, and with service facilities within 100 miles of project.
C. Testing Agency: Company specializing in testing products specified in this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETING

A. Section : Administrative Requirements: Pre-installation meeting.
B. Convene minimum one week prior to commencing Work of this section.

PART 2 PRODUCTS

2.1 Computer Network

- A Full Network Documentation Including Cables Paths, cable labeling, Points Labeling, Points Testing Reports, Must Be Submitted after Implementation (As Built Drawing).
- All Cables Must Be In Conduits Or Trays.
- All Accessories Should Be Cat-6A STP Type, And This Includes, RJ-45 Connectors, Patch Cords, and Patch Panels ….etc and must be same brand End-End solution.
- Riser diagram must be clear for the new design.
- The riser uplinks for the Data Network must be far away enough from the high current Cables, and the path for the uplinks must be close enough to the IT rrom.
- Active Components (Switches) must be provided as the required Specifications in the Document.
- Approved manufacturing list for the Switches:
  1- Cisco.
  2- Juniper.
  3- HP Aruba.

- Approved manufacturing list for the Data Cabling (Sample is Required to approve the brand).
- Number of patch panels/cabinet, and number of Switches will be depend on number of Data Points/floor, and based on the furniture Diagram, and will be determined through the next meeting.
- The copper STP cat6A patch cords (1-m and 3-m per Data Point) must be provided and plugged right in each cabinet.
- All cabinets are connected to UPS power supply only.
- BOQ table must be reviewed to isolate Items from each other.

2.2 Cable specifications

CAT-6A STP Cables	
1	USA or Europe Made Only
2	Central Cross Member to Reduce Risk of Crushing
3	Specified Up To 250 Mhz.
4	Low Weight
5	305 To 0 Meter Marking
6	23awg Conductor
7	Shielded cable

2.3 Connector & Faceplate specifications

CAT 6A Faceplate	
1	RJ-45 Jack Connector Interface ▪ Cat- 6A Compliant ▪ Two Piece, Easy to Use Design ▪ Multi use if needed ▪ Tool-Less Termination ▪ Suitable For Patch Panel and Faceplate Mounting
2	Complies With CAT-6 Standards
3	Must Be Provided with All Its Connectors And Accessories
4	Compatible With the Provided Cabling System
5	All Points Must Be Clearly Labeled

2.4 Cabinet's specifications:

2.4.1 42U Rack Cabinets

Rack Cabinet (42U) Main cabinet	
1	USA or Europe Made Only
2	Free stand
3	Min. 2 Fans
4	Front Glass Door with Lock
5	Power Strip (Minimum 12 Outlets) 2x6 MK outlets
6	Lockable, Removable Side Panels
8	One Shelf
9	The Cabinet Must Be Supplied with All Its Accessories
10	500mm Deep

2..4.2 CABINETS

Data Cabinet (size as shown in drawings) Branch cabinets	
1	USA or Europe Made Only
2	Wall mounted / free stand
3	Min. 2 Fans
4	Front Glass Door with Lock
5	Power Strip (Minimum 6 Outlets) 1x6 MK outlets
6	Lockable, Removable Side Panels
8	One Shelf
9	The Cabinet Must Be Supplied with All Its Accessories
10	500mm Deep

2.5 Patch Panel specifications:

CAT 6A Patch Panel	
1	24 Ports, 1U Height
2	RJ-45 Jack Connector Interface ▪ Cat- 6A Compliant ▪ Two Piece, Easy to Use Design ▪ Multi use if needed ▪ Tool-Less Termination ▪ Suitable For Patch Panel And Faceplate Mounting
3	Complies With CAT 6A Standards
4	Must Be Provided with All Its Connectors And Accessories
5	Compatible With the Provided Cabling System
6	All Ports Must Be Clearly Labeled

2.6 Patch Cords specifications:

CAT 6A STP Patch Cord – 1m	
1	Factory Made
2	Complies With CAT 6A Standards
3	Specified Up To 250 MHz
4	Compatible With the Provided Cabling System
5	Individually Bagged
CAT 6A STP Patch Cord – 3m & 5m	
1	Factory Made
2	Complies With CAT 6A Standards
3	Specified Up To 250 MHz
4	Compatible With the Provided Cabling System
5	Individually Bagged

2.7 Switch Specifications

#	Switches: Enterprise Business Switches - All Needed Cables and Accessories That's Needed to Operate the switch should be added.		Notes
1.	**Origin**	American or European Only	
2.	**Model**	Enterprise business model	
3.	**Needed Ports**	• 24 x 1G Base-TX, RJ-45 Port. • 2 x 1G SFP ports (not shared ports) • console port with console cable	
4.	**Switch Capacity**	52 Gbps	
5.	**MAC Table Size**	8K	
6.	**Power Supply**	Full POE (Power Over Ethernet)	
7.	**Port security**	802.1x	
8.	**VLANs**	Provide up to **4,000 VLAN IDs**	
9.	**Remote Access protocols**	• HTTP • Telnet • SSH	
10.	**Supported Protocols**	• Simple Network Management Protocol (SNMPv1/v2/v3) • Link Layer Discovery Protocol (LLDP)	
11.	**Architecture**	• Non-blocking architecture	
12.	**Management**	• Web graphical user interface (GUI) • Command-line interface (CLI) • remote monitoring	
13.	**DHCP**	• support DHCP Snooping and Dynamic ARP Inspection	
15.	**Warranty**	5 Years Certified Warranty from The Mother Company and Local Company.	
16.	**Approved manufacturing list**	1-Cisco 2-Juniper. 3-HP Aruba	

2.8 Main Building's Data Switch

•Redundant core switch design
• Advanced Layer 3 switch series with backplane stacking, Dynamic Segmentation, low latency, and resiliency.
• Advanced security and network management.
• Modular line rate 10GbE and 40GbE ports for wireless aggregation.
• Smart Rate for high-speed multi-gigabit bandwidth (IEEE 802.3bz) and PoE+ power
• Software defined ready with REST APIs and OpenFlow support
• 16 SFP+ fixed 1000/10000 SFP+ ports; Duplex: 100BASE-TX: half or full; 1000BASE-T: full only. Ports 1 – 16 support MAC Sec 2 open module slots Supports a maximum of 8 SFP+ ports or 2 40GbE. ports, with optional module or 4 Smart Rate ports
• Each switch must have two 4 port Stacking Module
• 3m Stacking Cable.
• Each switch must have two 12VDC 250W Power Supply
• 20 X 1G SFP for main cabinet.

END OF SECTION

SECTION – 16760
IP TELEPHONY SYSTEM

PART 1 GENERAL

PART 2 Product Specifications & Scope of Works:

2.1 Phones:

2.1.1 Scope of Works

- Providing new IP telephony devices with all its Accessories.
- Provide image upgrades for all devices after delivery.
- The system should be fully compatible with the current "Avaya" controller which is already implemented in some of SSC branches and should work with it without any issues or interruption of the service.
- Any additional licenses for the current controller and gateways should be included.
- System can be provided based on the current Avaya system or as a service.
- Install phones in the HQ site and digital branch site include configuration and testing.
- Providing a Clear Action Plan That Reflects All Phases of This Project.
- Provide configuration on all phones.
- 3 Years Warranty from the Mother Company on All Provided Items.
- 3 Years technical support From the Local Company on All Provided Item.

2.1.2 Specifications

Items and Minimum Required Specifications:

Phones:

	Mid-level phones Include patch cords cables and all accessories	Comply
1	PoE class 1 or 2 only (in case of class 3 or 4 standalone power adapters should be included.)	
2	Dual-port 10/100/1000 Ethernet switch for network and PC connections	
3	High-resolution, widescreen color display	
4	A min of 5 x Programmable (line) keys	
5	Static and dynamic IP address configuration	
6	Full duplex speakerphone for flexibility with hands-free communications	
7	Fixed keys for common telephony features: hold, redial, transfer	
8	Support for Session Initiation Protocol (SIP)	
9	3 years warranty	

	High-level phones Include patch cords cables and all accessories	Comply
1	PoE class 1 or 2 only (in case of class 3 or 4 standalone power adapters should be included.)	
2	Dual-port 10/100/1000 Ethernet switch for network and PC connections	
3	High-resolution, 5.0” widescreen color display	
4	A min of 5 x Programmable (line) keys	
5	Static and dynamic IP address configuration	
6	Full duplex speakerphone for flexibility with hands-free communications	
7	Fixed keys for common telephony features: hold, redial, transfer	
8	Support for Session Initiation Protocol (SIP)	
9	HD Video Camera	
10	3 years warranty	

2.2 IP telephony Gateway:

2.2.1 Scope of Works

- Providing new Avaya IP500V2 Gateway with all of its Accessories.
- Providing Trunks (External Lines)PRI 15 CH as in SPECs
- Providing Internal & External Lines as in SPECs
- System should be fully compatible with the current "Avaya" controller which is already implemented in SSC HQ site and some of SSC branches and should work with it without any issues or interruption in the service.
- Any additional licenses for the current controller should be included.
- 3 Years Warranty from the Mother Company on All Provided Items.
- 3 Years technical support From the Local Company on All Provided Item.

2.2.2 Specifications

Main Gateway (Avaya IP500V2)			
System part	**QNT**	**Comply /Not Comply**	**Notes**
IPO IP500 V2 CNTRL UNIT	1		
IPO IP500 V2 SYS SD CARD AL	1		
IPO IP500 RACK MNTG KIT	1		
IPO R11 SE LIC	1		
IPO REM SUPT 8X5 - HP DL120G7 1YPP	3		
IPO PWR LEAD (EARTHED) UK	1		
Trunks (External Lines)PRI 15 CH			
System part	**QNT**	**Comply /Not Comply**	**Notes**
IPO IP500 TRNK PRI UNVRSL SNGL	1		
IPO R10+ IP500 E1 ADD 8CH	1		
Internal & External Lines			
System part	**QNT**	**Comply /Not Comply**	**Notes**
IPO IP500v2 COMBO CARD ATM V2	1		
IPO MC VCM 64 V2	1		

END OF SECTION

HOLY ROCK
Consultant Engineers
الصخرة المشرفة
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المواصفات الفنية للأعمال الميكانيكية

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MECHANICAL SPECIFICATIONS

TABLE OF CONTENT

HVAC SPECIFICATIONS

15010	BASIC MECHANICAL REQUIREMENTS
15060	HANGERS, SUPPORTS AND FIRE STOPPING
15070	MECHANICAL SOUND, VIBRATION AND SIESMIC CONTROL
15075	MECHANICAL IDENTIFICATION
15120	PIPING SPECIALTIES
15739	SPLIT SYSTEM AIR CONDONING UNITS
15741	VARIABLE REFRIGERANT FLOW (VRF) SYSTEM
15810	DUCT WORK
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SECTION 15010

BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE OF WORK

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

II. The following specifications may be used as a guide for pricing but the Contractor will be fully responsible for the mechanical services as indicated diagrammatically on the drawings and to supply complete Mechanical Services Installations to the approval of the Engineer and complying with the aesthetic requirements of the Architect/Interior Designer.

1.2 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 systems and 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.

III. The Contractor shall provide and submit to the Engineer all calculations, drawings and supporting data for the mechanical equipment.

IV. 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.

1.3 SUBMITTALS

A. The Contractor shall provide submittals (3 copies minimum) as directed in the individual sections including also compliance sheet, origin catalogues, and samples, and the contractor shall mark up all submitted models and specified information on the catalogue.

B. The Contractor shall provide method statements for installation procedures of ductwork, pipe work, plant, equipment and automatic controls and all specialised systems.

1.4 WORKING DRAWINGS (SHOP 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 1:50

2. Co-ordinated detailed layouts of plant rooms and similar spaces to a scale of not less than 1:20.

3. Schedules of all equipment to be installed, together with starting and full load current and running power consumption along with any integral power factor correction capacitors.

4. Indicate with accurate dimensions sizes and positions of all plant, equipment, pipes, thermal and acoustic insulation, conduits, cable tray, cables together with all inspection points and cable joints.

5. Fully indicate all ductwork, pipe work, sizes and positions of all plant equipment and valves together with all inspection points and test positions.

6. Fully indicate all builders' work requirements inclusive of all foundations, bases, plinths, sumps and holes together with the overall sizes and masses of the plant concerned.

7. Indicate the number, size and services for every cable, duct, pipe for every service within the building.

8. Indicate all equipment and control wiring diagrams for all systems.

9. Show all pipes, cables and ducts in pits and service ducts on drawings to a scale of 1:50 or larger.

10. Show clearly all plumbing and drainage and setting out dimensions for all drainage pipe work and manholes, both within the building and throughout.

11. Services zoning principle in cross-section for each ceiling void area having extensive engineering. The sections are to demonstrate the sizes, dimensions of zones allocated for separate HVAC, public health, electrical, and other engineering services along with services cross-over zones, support/brackets zones thermal insulation, clearance and maintenance allowances to demonstrate the correct coordination.

12. Fully indicate extent and construction/installation details for all acoustic, noise and vibration control systems including inertia bases and plant room.

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 manufacturers' 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, lift, fire protection, plumbing, drainage and irrigation works, and other 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.

G. Each drawing shall have blank area of 18 cm X 12 cm located adjacent to the title block and reserved for the comments of the engineer. The title block shall display the following:

1. Number and title of drawing.
2. Date of drawing or revision.
3. Name of project and employer.
4. Name of consultant.
5. Name of contractor and sub-contractor submitting the drawing.
6. Clear identification of contents and location of work.
7. Legend for all symbols.
8. Specification title and number.
9. scale of drawing.

H. the approval of drawing will be general, but approval shall not be constructed as permitting any departure from the contract requirements, nor relieving the contractor of the responsibility for any errors including details, dimentions…etc, and specified performance of equipment.

1.5 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 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 and two dye-line prints and computer files on CD.

1.6 REGULATIONS

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 regulations and standards must be followed: -

A. Standards issued by Jordanian Standards Organisation
B. British and/or American Standard Specifications
C. British and/or American Standard Code of Practice

D. UK IEE Regulations for Electrical Installation
E. US National Electrical Code
F. US National Electrical Safety Code
G. UK Chartered Institution of Building Services Engineers (CIBSE)
H. The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
I. Electrical Regulations issued by JEPCO
J. US Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
K. US National Fire Protection Association Standards (NFPA)
L. IEE Regulations for Electrical Equipment of Buildings
M. Local Laws, Rules and Regulations
N. U.K. CIBSE Commissioning codes for Air, Water, Refrigeration and Controls Installations.
O. One copy of all the above codes and standards in hard-copy are to be held on site for the duration of the contract and be available for reference by the Contractors and Clients Site Supervision Teams.

1.7 WORKMANSHIP AND MATERIALS

A. The Contractor shall be responsible for ensuring that the components for 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 that 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. 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.

F. 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 shall be rejected.

G. Castings repaired by welding for major defects shall be stressed-relieved after such welding.

H. Non-destructive tests will be required for any casting containing defects whose extent cannot otherwise be judged, or to determine that repair welds have been properly made.

I. All major stress-bearing forgings shall be made to a standard specificationthat 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.

J. Particular attention shall be paid to the prevention of corrosion due to the closeproximity 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 HM Stationary Office entitled "Corrosion and its Prevention at Bimetallic Contacts" shall be used as a guide.

K. The use of iron and steel shall be avoided in instruments and electrical relayswhereverpossible. 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 restless steel where possible.

1.8 INSPECTION AND TESTS AT MANUFACTURER'S WORKS

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 a 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.

E. 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.

F. Works tests shall also be carried out with due consideration is given to the Site conditions under which the mechanical equipment is required to function. The test certificates shall give all details of such tests.

G. Specific performance works tests are described in the relevant Sections of Division 15, and include all major items of Mechanical, HVAC and Plumbing plant and equipment.

1.9 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 showing the exact dimensions and details of items of the mechanical equipment, as they will be supplied and installed on the site.

1.10 SAMPLES

A. The Contractor shall provide 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 packedand protected suitable for prolonged storage in a humid and saline atmosphere.

B. 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 of the ground on suitable timbers to the approval of the Engineer.

C. 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 that may be damaged by heat or sun shall be protected accordingly. All open pipe 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.

B. 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.

C. Guards to V-belt drives shall be made of galvanised steel wire of at least 12 gauge, with a mesh notgreater than 12.5mm attached to a rigid galvanised framework of rods of not less than 10mm diameter. The guard shall be readily removable to permit the belts to be changed. Adequate access panels shall be provided in the side of the guard to allow tachometer readings of the two shafts to be taken and belt tension tested. Allowance shall be made for the adjustment of the motor on its slide rails.

1.13 CLEANING

A. 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 or 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.

1.14 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.

1.15 PAINTING

A. The preparation, painting and treatment of mechanical equipment surfaces shall be in accordance with relevant items in Division 15 and Division 9.

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 that occurs shall be made good by the Contractor at his own cost to the satisfaction 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 shop 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 pipe work, brackets and ductwork shall be carried out in accordance with Division 9.

1.16 MANUFACTURER'S NAMEPLATES

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

1.17 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 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, functionand, where necessary, phase, voltage, current, frequency, pressure and temperature. All labels shall be in Arabic and English.

1.18 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, a lithium base grease is preferred.

B. Where lubrication is affected by means of grease, preference shall be given to a pressure system that 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. 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.

1.19 SPECIAL TOOLS

A. The Contractor shall supply free of charge 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.

1.20 SUNDRY BUILDERS WORK IN CONNECTION WITH SERVICES

A. The Contractor shall include in his prices for drilling, raw bolting, plugging, screwing and nailing of all brackets and 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.

1.21 NOISE

A. Noise Criteria

Refer to Specification Section 15070.

B. 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 BS 8233 shall be followed wherever necessary. The Contractor shall prepare detailed noise level calculations to indicate the anticipated noise levels in all occupied areas. Fan chambers, technical rooms and chillers yardshall be constructed to ensure that noise levels in surrounding spaces meet specified levels.

C. All possible steps shall be taken, (e.g. by the use of sound insulation, anti-vibration mountings, floating floors, walls, ceilings and careful design of pumps, motors, fans, ducts, bends, dampers, grilles and other equipment) to reduce the noise produced by the mechanical equipment.

D The Contractor shall determine the noise levels of all primary mechanical equipment before proceeding with manufacture and submit sound power levels of such equipment and resultant room noise levels to the Engineer for approval before manufacture is commenced.

1.22 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 structure.

B. All fans, motors, compressors, pumps 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. Pumps shall be installed on inertia bases. 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 in

excess of 98% 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.

1.23 AS BUILT DRAWINGS

A. “As Built” record drawings are to be produced as the installation work is completed. The working drawings shall be checked against the installation, corrected and issued for approval. The Contractor shall provide a delivery schedule of the drawing submissions based on the construction programme. Thirty days prior to the date of the handing over certificate, the Contractor shall provide the final copy of the "as built" record drawings of the whole works for approval.

B. The Drawings shall include the following:-

A. General arrangements of all services to a scale of not less than 1:50.

B. Detailed layouts of plant rooms and similar spaces to a scale of not less than 1:20.

C. Schedules of all plant and cross referenced equipment to the maintenance manual.

D. All equipment and control wiring diagrams. Diagrams must be co-ordinated and show all required interlocks etc. between systems or components.

E. 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.

F. 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.

G. 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.

H. Indicate the number, sizes and services for every cable, duct, and 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.

I. Show clearly on site drawings all the new buildings together with all other existing buildings and other permanent features with dimensions between such buildings

J. Cables, pipes, ducts, etc. clearly marked, together with installed backfill and

surround to each services.

K. Show clearly all plumbing and drainage and setting out dimensions for all drainage pipe work and manholes both within the building throughout the site, together with drainage pipe work backfill, or surround in each location. A schedule shall be included to indicate each manhole size, cover size, invert level and ground level.

L. The symbol used for each service for all as built drawings shall be shown on separate drawings.

M. In order to achieve 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.

N. 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.

O. In addition to the ”as built drawings”, the Contractor shall obtain and provide two sets of all manufacturers’ detailed drawings for all items of plant, equipment, apparatus and materials. These drawings shall be suitably titled and have drawing reference numbers added.

P. The Contractor shall provide two copies of all “as built drawings” for review comments and approval. Upon receiving approval in writing from the Engineer,

Q. on 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.(Hard and soft on CD) copies of the operating instructions specified in clause 1.25.

1.24 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 as the work progresses 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.

B. Overall general description of the complete equipment installed together with the method of functioning.

C. Full technical descriptions of each and every item of equipment, including the electrical circuit details as applicable.

D. Operating procedures for each section of the works and each individual item of equipment or plant.

E. Planned maintenance schedules for the installation and its component parts to include commissioning performance details and measurements.

F. Schedule of components comprising each and every item of equipment including manufacturer's name, description and part number of each

component.

G. 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.

H. Complete name of manufacturer, postal address, contact person telephone, telefax and E mail shall be tabulated for ease in procurement of spare parts. Spare parts forms (standard) shall be prepared.

I. 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.

J. Each section shall be encased in a loose-leaf ring binder covered in plastic material of an approved colour and of a type that shall be flat when open.

K. The Contractor shall include for the preparation and supply of six copies of the above operating and maintenance instructions for each section after the Engineer has approved all details.

L. Electronic transfer of "As Built" drawings shall be provided as required by the Engineer.

1.25 INSTRUCTION AND TRAINING

I. 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.

II. The Contractor shall provide a fully working and completely documented electronic planned preventative maintenance schedule (PPM). The PPM shall contain all the recommendations of the individual manufacturers of the equipment installed and recognised good practice, along with training of the Clients staff.

END OF SECTION 15010

SECTION 15060

HANGERS, SUPPORTS AND FIRESTOPPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Mechanical supports and hangers.
2. Expansion slides and compensators.
3. Inserts.
4. Flashing.
5. Equipment curbs.
6. Sleeves.
7. Mechanical sleeve seals.
8. Fire stopping relating to mechanical work.

1.2 DEFINITIONS

A. Fire stopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.3 PERFORMANCE REQUIREMENTS

A. Firestopping: Conform to applicable code FM UL WH for fire resistance ratings and surface burning characteristics.

B. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

1.4 SUBMITTALS

A. Shop Drawings: Indicate layout for all mechanical and electrical systems with location including critical dimensions, sizes, forall hangers and supports locations and details ,sizes ,numbers of hangers and supports shall be certified by the manufacturer or his representative .

B. Product Data:
1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
2. Firestopping: Submit data on product characteristics, performance and limitation criteria.

C. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.

D. Design Data: Indicate load carrying capacity of trapeze, multiple, and riser support hangers. Submit calculations used to determine load carrying capacity of each type of support and hanger for the engineer's approval.

E. Manufacturer's Installation Instructions:
   1. Hangers and Supports: Submit special procedures and assembly of components.
   2. Firestopping: Submit preparation and installation instructions.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.6 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 MECHANICAL SUPPORTS AND HANGERS

A. All installation material used for supporting and fixing mechanical piping and ducting systems shall be of a modern type that gives tested reliable supporting solution without the need for welding, drilling or subsequent galvanizing for corrosion protection.

B. The mechanical supporting and hanging system shall consist of the following components:
   1. C-Channels shall be used as the main item for supporting all pipes and duct work. C-Channels shall be constructed of rolled galvanized steel strip with galvanization thickness of 20 microns. Contractor must submit mechanical drawing showing all support locations combined with detailed load calculation. Where the channel is cut, suitable end caps shall be used to protect the cut from corrosion. C-Channels of minimum thickness of 2mm and width of 40mm shall be used for all applications, and the height to be selected according to load calculation.
   2. C-Channel accessories as recommended by the channel manufacturer, shall be used to assemble various channel structures as appropriate for the application. These accessories include single-part components for attaching connectors, fixing nuts with serration, angles, brackets and pipe ring saddles. All parts shall be made of galvanized steel.
   3. Pipe Ring Clamps: For chilled water pipes and, cold domestic pipes; galvanized, pre-engineered pipe ring clamps should be used

for fixing all pipes to channel system or directly to the correct structure. The contractor shall verify that the pipe supported weight does not exceed the recommended maximum load of the clamp as provided by manufacturer. The pipe rings should be of a double screw type. Medium duty pipe rings shall be used for pipes up to 80mm diameter and heavy duty pipe rings shall be used for sizes 100mm and above except for the fire fighting system, the vertical pipes shall be supported by heavy duty double screw pipe rings without rubber and shall be UL listed. All pipe rings used for copper pipes and hot-chilled water steel pipes should be provided with a pre-fitted rubber inlay. Rubber inlay shall be made of EPDM material inspected for sound insulation with temperature resistance range -40 to 110°C.

4. Threaded rods shall be manufactured of steel grade 4.6. Rods, nuts and flat washers shall be clean threaded and flawless galvanized conditions.
5. Concrete anchors: shall be internally threaded for fixing rods, made of galvanized zinc plated and passivated steel. Anchor shall have FM, VDS and fire resistance approval. Zinc plated and passivated steel bolt anchor with suitable diameter should be used for fixing channels into concrete. Furnish calculations to substantiate selected sizes.
6. Duct work supports: Pre-manufactured C-Channels shall be used as the main item for supporting ducts. Supports for vertical duct shall be located to coincide with the individual floor slabs subject to a maximum spacing of 4 meters.

2.2 EXPANSION SLIDES

A. Furnish thermal expansion sliding elements and anchors for hot water , chilled water and steam pipes to prevent build-up forces at the pipe clamp and the fixing points. The glider shall provide sufficient slide way distance according to the manufacturer load limit and movement limit. Provide thermal expansion calculations for all net works with selection and installation details for the engineer's approval.

B. For pipe risers furnish special fabricated steel arms supported on slabs as cantilever and to be welded on pipe sides to hold the pipe weight. Provide manufacturer's details for the engineer's approval.

2.3 INSERTS

Furnish inserts with malleable iron case, galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 FLASHING

A. Metal Flashing: 0.7 mm thick galvanized steel.

B. Metal Counterflashing: 0.8 mm thick galvanized steel.

C. Flexible Flashing: 1.2 mm thick sheet compatible with roofing.

D. Caps: Galvanized steel 0.8 mm minimum; 1.5 mm at fire resistant elements.

2.5 EQUIPMENT CURBS

A. Concrete curbs are to be provided as recommended by manufacturer of equipment.

2.6 SLEEVES

A. Sleeves for Ø up to 100 mm DiaPipes Through Floors & Wet Floors: sleeves shall be steel pipe with extension of 25 mm above finish floor level, and clearance between pipes and sleeves shall be 1 inch and to be filled with approved mechanical sleeve seals or fire stop material (Fire walls &floors).

B. Sleeves for Ø above 100 mm Dia Pipes Through Floors & Wet Floors: sleeves shall be 1.2 mm thick galvanized steel with extension of 25 mm above finish floor level, and clearance between pipes and sleeves shall be 2 inchs and to be filled with approved mechanical sleeve seals or fire stop material (Fire walls &floors) .

C. Sleeves for Ø up to 100 mm Dia Pipes Through Beams, Walls, Footings: sleeves shall be steel pipe with 1 inch clearance between pipes and sleeves and to be filled with approved mechanical sleeve seals or fire stop material (Fire walls & floors) .

D. Sleeves for Ø above 100 mm Pipes Through Beams, Walls, Footings: sleeves shall be 1.2 mm thick galvanized steel with 1 inch clearance between pipes and sleeves and to be filled with approved mechanical sleeve seals or fire stop material (Fire walls & floors)

E. Sleeves for Round Ductwork: Galvanized steel.

F. Sleeves for Rectangular Ductwork: Galvanized steel or wood.

2.7 MECHANICAL SLEEVE SEALS

A. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.8 FIRESTOPPING

A. Definition: Fire stopping material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, water and hot gases through penetrations in fire rated wall and floor assemblies.
B. Performance Requirements: Provide firestopping systems which have been manufactured and installed to maintain performance criteria stated by manufacturer without defects, damage or failure.

C. Engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having the necessary experience, staff, and training to install manufacturer's products per specified requirements. A manufacturer's willingness to sell its firestopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.
D. Compliance: Comply with manufacturer's product data including product technical bulletins, product catalog installation instructions and product carton instructions.

E. Application of fire stop systems:
    1. Penetrations for the passage of duct, cable, cable tray, conduit, piping, electrical bus ways and raceways through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.(gaps between sleeves and the passage duct ,pipe,…etc)
    2. Slot gaps between edge of floor slabs and curtain walls.
    3. Openings between structurally separate sections of wall or floors.
    4. Gaps between the top of walls and ceilings or roof assemblies.
    5. Expansion joints in walls and floors.
    6. Openings and penetrations in fire-rated partitions or walls containing fire doors.
    7. Openings around structural members which penetrate floors or walls.
    8. Multiple electrical boxes located within the same stud cavity.

F. Firestopping materials: The following materials are listed for guidance for the types of firestopping materials required for the installation. The contractor shall add to the list at no extra charge further materials if found necessary to complete the installation or if required by the fire authority:
    1. Silicone Firestopping Elastomeric Firestopping: Multiple component silicone elastomeric compound and compatible silicone sealant.
    2. Foam Firestopping Compounds: Multiple component foam compound.
    3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
    4. Fiber Stuffing and Sealant Firestopping: Composite of ceramic fiber stuffing insulation with silicone elastomer for smoke stopping.
    5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet

stainless steel jacket, joined with collars, penetration sealed with flanged stops.

6. Intumescent Firestopping: Intumescent putty, collars and sealant compound which expands on exposure to surface heat gain.
7. Firestop Pillows: Formed mineral fiber pillows.
8. Flexible joint spray.
9. Trowelable firestop compound.
10. Cast in-place firestop device.
11. Equivalent products listed in the U.L fire resistance directory.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify openings are ready to receive sleeves.

B. Verify openings are ready to receive firestopping.

3.2 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.

B. Remove incompatible materials affecting bond.

C. Obtain permission from Engineer before using powder-actuated anchors.

D. Do not drill or cut structural members.

E. Obtain permission from Engineer before drilling or cutting structural members.

F. Firestopping Surface Preparation: Prepare surface to receive firestop system products in accordance with manufacturer’s instructions for surface preparation.

1. Verify penetrations are properly sized and in suitable condition for application of materials.
2. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.
3. Do not proceed until unsatisfactory conditions have been corrected.

3.3 INSTALLATION - INSERTS

A. Install inserts for placement in concrete forms.

B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 100 mm and larger.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install in accordance with ASME B31.1.

B. Support horizontal piping as scheduled.

C. Install hangers with minimum 13 mm space between finished covering and adjacent work.

D. Place hangers within 300 mm of each horizontal elbow.

E. Use hangers with 38 mm minimum vertical adjustment.

F. Support horizontal cast iron pipe adjacent to each hub, with 1.5 m maximum spacing between hangers.

G. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

H. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.

I. Support riser piping independently of connected horizontal piping.

J. Provide copper plated hangers and supports for copper piping .

K. Design hangers for pipe movement without disengagement of supported pipe.

L. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

M. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 15080.

3.5 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete as detailed on drawings or a minimum 150 mm thick and shall be 100 mm above finished floor level and extending 150 mm beyond supported equipment.

B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

C. Construct supports of steel members or formed steel channel or steel pipe and fittings. Brace and fasten with flanges bolted to structure.

D. Provide rigid anchors for pipes after vibration isolation components are installed. Refer to Section 15070.

3.6 INSTALLATION - FLASHING

A. Provide flexible flashing and metal Counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

B. Flash vent and soil pipes projecting 75 mm minimum above finished roof surface with lead worked 25 mm minimum into hub, 200 mm minimum clear

on sides with 600 x 600 mm sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter-flash, and seal.

C. Flash floor drains in floors with topping over finished areas with lead, 250 mm clear on sides with minimum 910 x 910 mm sheet size. Fasten flashing to drain clamp device.

D. Seal floor drains watertight to adjacent materials.

E. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms for sound control.

F. Provide curbs for mechanical roof installations 350 mm minimum high above roofing surface. Flash and counter-flash with sheet metal; seal watertight. Attach Counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.

G. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.7 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with mechanical sleeve seals.

B. Set sleeves in position in forms. Provide reinforcing around sleeves.

C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

D. Extend sleeves through floors 25 mm above finished floor level. Caulk sleeves.

E. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with stuffing or firestopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

F. Install stainless steel escutcheons at finished surfaces.

3.8 INSTALLATION - FIRESTOPPING

A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, and other items, requiring firestopping.

B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.

C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating, to uniform density and texture.

D. Place foamed material in layers to ensure homogenous density, filling cavities and spaces. Place sealant to completely seal junctions with adjacent dissimilar materials.

E. Remove dam material after firestopping material has cured.

F. Fire Rated Surface:
   1. Seal opening at floor, wall, partition, ceiling, and roof as follows:
      a. Install sleeve through opening and extending beyond minimum of 25 mm on both sides of building element.
      b. Size sleeve allowing minimum of 25 mm void between sleeve and building element.
      c. Pack void with backing material.
      d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.
   2. Where cable tray, bus, cable bus, conduit, wireway, and trough, penetrates fire rated surface, install firestopping product in accordance with manufacturer's instructions.

G. Non-Rated Surfaces:
   1. Seal opening through non-fire rated wall, partition floor, ceiling, and roof opening as follows:
      a. Install sleeve through opening and extending beyond minimum of 25 mm on both sides of building element.
      b. Size sleeve allowing minimum of 25 mm void between sleeve and building element.
      c. Install type of firestopping material recommended by manufacturer.
   2. Install escutcheons where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
   3. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place, in accordance with manufacturer's instructions.
   4. Interior partitions: Seal pipe penetrations at computer rooms, telecommunication rooms data rooms. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

3.9 FIELD QUALITY CONTROL

A. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.10 CLEANING

A. Clean adjacent surfaces of firestopping materials.

3.11 PROTECTION OF FINISHED WORK

A. Protect adjacent surfaces from damage by material installation.

3.12 SCHEDULES

A.

PIPE MATERIAL	PIPE SIZE (mm)	THREADED ROD DIA.	MAXIMUM HANGER SPACING (m)
Galvanized Steel Threaded	15 – 25	8mm	1.2
	32	8mm	1.6
	40 – 50	8mm	1.9
	65– 108	10mm	2.2
	125	10-12mm	2.5
	150	10-12mm	2.6

B.

PIPE MATERIAL	PIPE SIZE (mm)	THREADED ROD DIA.	MAXIMUM HANGER SPACING (m)
Black Steel Seamless Welded or Grooved	15	8mm	1.6
	20 – 32	8mm	2.0
	40 – 65	8mm	2.7
	80	10mm	4.5
	100	10mm	5
	125 – 150	10-12mm	6
	200 – 300	12-16mm	7

C.

PIPE MATERIAL	PIPE SIZE (mm)	THREADED ROD DIA.	MAXIMUM HANGER SPACING (m)
Copper	8 -12	8mm	1.0
	15 - 20	8mm	1.3
	25 - 40	8mm	1.7
	50	8mm	2.2
	65 - 80	10mm	3.3
	100	10-12mm	4.0

D.

PIPE MATERIAL	PIPE SIZE (mm)	THREADED ROD DIA.	MAXIMUM HANGER SPACING (m)
Cast Iron	40	8mm	1.5
	50	8mm	1.5
	75	10mm	1.5
	100	10mm	1.5
	150	10-12mm	1.5

E.

PIPE MATERIAL	PIPE SIZE (mm)	THREADED ROD DIA.	MAXIMUM HANGER SPACING (m)
PVC	40	8mm	1.5
	50	8mm	1.5
	75	10mm	1.5
	100	10mm	1.5
	150	10-12mm	2.0

F.

PIPE MATERIAL	PIPE SIZE (mm)	THREADED ROD DIA.	MAXIMUM HANGER SPACING (m)
PP-RCT	40	8mm	1.5
	50	8mm	1.5
	75	10mm	1.5
	100	10mm	1.5
	150	10-12mm	2.0

END OF SECTION 15060

SECTION 15070

MECHANICAL SOUND, VIBRATION AND SEISMIC CONTROL

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Inertia bases.
2. Vibration isolators.
3. Duct silencers.
4. Cross-talk silencers.
5. Ductwork lagging.
6. Acoustical louvers.
7. Floating Floor.

1.2 PERFORMANCE REQUIREMENTS

A. All mechanical electrical equipment, piping and ductwork as noted on the equipment schedule or in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure.

B. All piping and ductwork located in mechanical equipment rooms, and for a minimum of 15m, whichever is greater, from any connection to vibration isolated mechanical or electrical equipment, shall be isolated from the building structure by means of noise and vibration hangers.

C. All isolators shall provide the required static deflection related to the equipment weight or the operational speed as indicated below.

D. Provide minimum static deflection of isolators for equipment as follows:
1. Basement, Under 15 kW
   a. Under 400 rpm: 30 mm
   b. 400 - 600 rpm: 25 mm
   c. 600 - 800 rpm: 12 mm
   d. 800 - 900 rpm: 5 mm
   e. 1100 - 1500 rpm: 4 mm
   f. Over 1500 rpm: 3 mm
2. Basement, Over 15 kW
   a. Under 400 rpm: 60 mm
   b. 400 - 600 rpm: 50 mm
   c. 600 - 800 rpm: 25 mm
   d. 800 - 900 rpm: 12 mm
   e. 1100 - 1500 rpm: 5 mm
   f. Over 1500 rpm: 4 mm
3. Upper Floors, Normal
   a. Under 400 rpm: 100 mm
   b. 400 - 600 rpm: 90 mm
   c. 600 - 800 rpm: 50 mm
   d. 800 - 900 rpm: 25 mm

e. 1100 - 1500 rpm: 12 mm
f. Over 1500 rpm: 5 mm

4. Upper Floors, Critical
   a. Under 400 rpm: 120 mm
   b. 400 - 600 rpm: 100 mm
   c. 600 - 800 rpm: 90 mm
   d. 800 - 900 rpm: 50 mm
   e. 1100 - 1500 rpm: 25 mm
   f. Over 1500 rpm: 12 mm

E. Consider upper floor locations critical unless otherwise indicated.

F. Use concrete inertia bases for fans having static pressure in excess of 0.85 kPa or motors in excess of 30 kW, and on all base mounted pumps over 7.5 kW.

G. Maintain sound level of spaces at levels not to exceed those listed below by utilizing acoustical devices.

H. Maintain rooms at following maximum sound levels, in Noise Criteria (NC) as defined by ASHRAE Handbook. HVAC Applications
   1. Guest Rooms: 35 (on medium speed)
   2. Halls, Corridors, lobbies: 40
   3. Offices: 40
   4. Restaurant: 40
   5. Meetings rooms: 35
   6. VIP offices: 35
   7. Shops: 45
   8. Back of house: 45
   9. Car park: 50

1.3 SUBMITTALS

A. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each equipment and system. Indicate assembly, materials, thickness, dimensional data, pressure losses, acoustical performance, layout, and connection details for sound attenuation products fabricated for this project.

B. Product Data: Submit schedule of vibration isolator type with location and load. Submit catalog information indicating, materials, dimensional data, pressure losses, and acoustical performance for standard sound attenuation products.

C. Design Data: Submit calculations indicating maximum room sound levels are not exceeded. Furnish calculations to substantiate the selection of vibration and noise isolators and sound attenuators for the engineer's approval. Indicate spring diameters, free operating and solid height, ratio of horizontal and vertical stiffness and other required data to meet the system requirements.

D. Test Reports: Indicate dynamic insertion loss and noise generation values of silencers.

E. Manufacturer's Installation Instructions: Submit special procedures and setting dimensions. Indicate installation requirements maintaining integrity of sound isolation.

F. Manufacturer's Certificate: Certify isolators meet or exceed specified requirements.

G. Manufacturer's Field Reports: Indicate sound isolation installation is complete and in accordance with instructions.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

C. Design application of duct silencers acoustic housings seismic snubbers under direct supervision of Professional Engineer experienced in design of this Work.

1.5 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 INERTIA BASES

Concrete Inertia Bases:

1. Mass: Minimum of 1.5 times weight of isolated equipment.
2. Construction: Structured steel channel perimeter frame, with gusset brackets and anchor bolts, adequately reinforced, concrete filled.
3. Connecting Point: Reinforced to connect spring isolators and snubbers to base.
4. Concrete: Reinforced 20 MPa concrete.
5. Machine shall be fixed to the base with grouted-in holding down bolts.

2.2 VIBRATION ISOLATORS

A. Open Spring Isolators:

1. Spring Isolators:
   a. Furnish hot dipped galvanized housings and epoxy powder coated springs.
   b. Code: Color code springs for load carrying capacity.

2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection and 50% overload capacity.
3. Spring Mounts: Furnish with leveling devices, minimum 6 mm thick neoprene sound pads, and zinc chromate plated hardware.
4. Sound Pads: Size for minimum deflection of 1.2 mm; meet requirements for neoprene pad isolators.

B. Restrained Spring Isolators:
1. Spring Isolators:
   a. Furnish hot dipped galvanized housings and epoxy powder coated springs.
   b. Code: Color code springs for load carrying capacity.
2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
3. Spring Mounts: Furnish with leveling devices, minimum 6 mm thick neoprene sound pads, and zinc chromate plated hardware.
4. Sound Pads: Size for minimum deflection of 1.2 mm; meet requirements for neoprene pad isolators.
5. Restraint: Furnish welded steel housing assemblies to limit vertical movement of the supported equipment.

C. Closed Spring Isolators:
1. Spring Isolators:
   a. Furnish hot dipped galvanized housings and epoxy powder coated springs.
   b. Code: Color code springs for load carrying capacity.
2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 7 mm clearance.

D. Restrained Closed Spring Isolators:
1. Spring Isolators:
   a. Furnish hot dipped galvanized housings and epoxy powder coated springs.
   b. Code: Color code springs for load carrying capacity.
2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 7 mm clearance and limit stops.

E. Spring Hanger:
   1. Spring Isolators:
      a. Furnish hot dipped galvanized housings and epoxy powder coated springs.
      b. Code: Color code springs for load carrying capacity.
   2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
   3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators.
   4. Misalignment: Capable of 20 degree hanger rod misalignment.

F. Neoprene Pad Isolators:
   1. Rubber or neoprene-waffle pads.
      a. 30 durometer.
      b. Minimum 13 mm thick.
      c. Maximum loading 275 kPa.
      d. Height of ribs: not to exceed 0.7 times width.
   2. Configuration: 13 mm thick waffle pads bonded each side of 6 mm thick steel plate.

G. Rubber Mount or Hanger: Molded rubber designed for 13 mm deflection with threaded insert.

H. Glass Fiber Pads: Neoprene jacketed pre-compressed molded glass fiber bonded to a steel load transfer plate and formed steel bolt down bracket with anti-short circuit neoprene grommet to prevent metal to metal contact.

I. Seismic Snubbers:
   1. Type: Non-directional and double acting unit consisting of interlocking steel members restrained by neoprene elements.
   2. Neoprene Elements: Replaceable, minimum of 18 mm thick.
   3. Capacity: 4 times load assigned to mount groupings at 10 mm deflection.
   4. Attachment Points and Fasteners: Capable of withstanding 3 times rated load capacity of seismic snubber.

J. Seismic Restraint for ceiling suspended equipment:
   1. Seismically support all suspended equipment above 200kg weight by seismic springs. Type and quantity to unit load. Furnish calculations for the engineer's approval.
   2. Seismically restrain all suspended equipment above 200kg weight. Use Type J aircraft Cable Restraints for all corners.
   3. Type J cable seismic restraint sizes, quantities, locations, and mounting details shall be as per ASHRAE and or SMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc.) "Seismic Restraint Manual Guidelines for Mechanical Systems", Second Edition

2.3 DUCT SILENCERS

A. Description: Duct section with sheet metal outer casing, sound absorbing fill material, and inner casing of perforated sheet metal; incorporating interior baffles of similar construction. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

B. Configuration: Rectangular with lined splitters with radius nose and contoured tails.

C. Materials:
   1. Outer Casing: Minimum 0.9 mm thick galvanized steel stiffened with welded seams, 50 mm long, 2.9 mm slip joints on both ends.
   2. Inner Casing and Splitters: Minimum 0.6 mm thick perforated galvanized steel.
   3. Fill: Glass fiber or mineral wool of minimum 64 kg/cu m density.
   4. Fill Liner: Bonded glass fiber matting.

D. Rating:
   1. ASTM E477 Insertion Loss and Maximum Generated Noise at 20 m/sec Face Velocity to meet space noise level criteria.
   2. Static Pressure Drop at 10 m/sec Face Velocity: 0.075 kPa.
   3. Air Tight Static Pressure: 2.5 kPa.

E. Performance: Achieve noise reduction as required to meet space noise level criteria.

2.4 CROSS-TALK SILENCERS

A. Description: Duct sections with sheet metal outer casing, sound absorbing fill material; incorporating interior baffles of similar construction. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

B. Configuration: Rectangular, lined with splitters with radius nosed and contoured tails.

C. Materials:
   1. Outer Casing: Minimum 0.8 mm thick galvanized steel with mastic filled lock formed seams, 75 mm long, 2.9 mm slip joint on both ends.
   2. Inner Casing and Splitters: Minimum 0.6 mm thick perforated galvanized steel.
   3. Fill: Glass fiber or mineral wool of minimum 64 kg/cu m density.
   4. Fill Liner: Bonded glass fiber matting.

D. Rating:
   1. Static Pressure Drop at 5 m/sec Face Velocity: 0.050 kPa.

2.5 DUCTWORK LAGGING

A. Acoustic Insulation: 19 mm thick elastomeric, closed cell rubber. Fixing with fire proof adhesive and mechanical fixing with self welding pins and galvanized steel washers.

2.6 ACOUSTICAL LOUVERS

A. Configuration: 200 mm deep louvers with blades on 45 degree slope; sound absorbing fill material, and inner surface of perforated sheet metal, channel frame, bird Screen.

B. Materials:
   1. Louvers: 2.50 mm extruded aluminum, welded assembly, with factory color anodized finish.
   2. Inner Surface: Minimum 0.6 mm thick perforated galvanized steel.
   3. Fill: Glass fiber or mineral wool of minimum 64 kg/cu m density.
   4. Fill Liner: Bonded glass fiber matting.
   5. Bird screen: 13 mm square wire mesh.
   6. Mounting: Exterior angle flange. Screw holes in jambs.

C. Rating:
   1. Insertion loss:
   Provide manufacturer data to meet space noise level criteria.

   2. Static Pressure Drop at 1.5 m/sec Face Velocity: 0.030 kPa.

2.7 FLOATING FLOOR

A. Proprietary floating floor systemshall be used for chillers, pumps, boilers, large condensing units and air handling units as indicated on drawings.

B. The floating floor shall consist primarily of an isolated concrete slab 100mm minimum thickness (2400 kg/m³) supported by sound isolated material of pre-molded fiberglass pads. The perimeter of the floating floor shall be isolated from adjoining walls, columns or curbs by means of perimeter isolation board of closed cell, expanded polyethylene, 20mm thick.

C. Support media “Noise and Vibration Pads” must provide a natural frequency of 10-15Hz or lower and shall remain constant within 2Hz over the entire load range of the floor system. Pads shall be designed to withstand a minimum imposed load of 200 PSF in all open areas, and shall have a minimum overload capacity of 100% in all high load areas. Pads shall be resistant to oil, water, acids and fungus.

D. Design: Provide full calculation for the isolation-floating floor showing loads, deflections. dimensions, material specifications and concrete reinforcement. Calculations shall be submitted for each area where this system is shown on drawings.

E. Carefully examine conditions at the job site before commencing work. Any surfaces not properly prepared to receive the work of this section shall be reported to the Engineer.

F. Shop drawings: full set shall be prepared for all areas and submitted for approval prior to commencement of work. Drawings shall show the construction of the various parts of the work. Including connections of the isolation system components to adjacent parts of the building structure.

G. Noise and vibration pads shall be surrounded by a mat of fiberglass having the same thickness of the pads. Pads shall be topped by a layer of plywood, 15mm thick, concrete pouring form. Plywood shall be covered by 150 micron polyethylene sheet prior to pouring concrete. Density of pads shall suit the equipment load and the concrete load.

H. Penetrations: piping, conduit or ductwork penetrations of the “floating floor” shall be isolated with 20mm, closed cell expanded polyethylene as specified for the perimeter isolation board.

I. Isolated floor drains: shall consist of two part units designed to be cast into the isolated slab and the structure slab with no rigid connection between the two members.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify equipment, ductwork and piping is installed before work in this section is started.

3.2 INSTALLATION

A. Support duct silencers rigidly to ductwork.

B. Install cross-talk silencers in wall. Calk wall penetrations.

C. Lag ductwork, where indicated by wrapping with insulation and covering. Apply covering to be airtight. Do not attach covering rigidly to ductwork.

D. Attach ductwork to acoustic louvers with flexible duct connections. Refer to Section 15820.

E. Install isolation for motor driven equipment.

F. Bases:
1. Set steel bases for 25 mm clearance between housekeeping pad and base.
2. Set concrete inertia bases for 50 mm clearance between housekeeping pad and base.

G. Adjust equipment level.

H. Install spring hangers without binding.

I. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

J. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

K. Provide pairs of horizontal limit springs on fans with more than 1.5 kPa static pressure, and on hanger supported, horizontally mounted axial fans.

L. Provide resiliently mounted equipment, piping, and ductwork with seismic snubbers. Provide each inertia base with minimum of four seismic snubbers located close to isolators. Snub equipment designated for post disaster use to 1.5 mm maximum clearance. Provide other snubbers with clearance between 4 mm and 7 mm.

M. Support piping connections to isolated equipment resiliently to nearest flexible pipe connector. as follows:
1. Up to 100 mm Diameter: First three points of support.
2. 125 to 200 mm Diameter: First four points of support.
3. 250 mm Diameter and Over: First six points of support.
4. Select three hangers closest to vibration source for minimum 25 mm static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 25 mm static deflection or 1/2 static deflection of isolated equipment.

3.3 FIELD QUALITY CONTROL

A. Inspect isolated equipment after installation and submit report. Include static deflections.

B. After start-up, final corrections and balancing of systems take octave band sound measurements over full audio frequency range in areas adjacent to mechanical equipment rooms, duct and pipe shafts, and other critical locations. Provide one-third octave band measurements of artificial sound sources in areas indicated as having critical requirements. Submit complete report of test results including sound curves.

C. Furnish services of a third party testing agency to take noise measurement. Use meters meeting requirements of ANSI S1.4.

END OF SECTION 15070

SECTION 15075

MECHANICAL IDENTIFICATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Nameplates.
   2. Tags.
   3. Stencils.
   4. Pipe markers.
   5. Ceiling tacks.
   6. Labels.
   7. Lockout devices.

1.2 SUBMITTALS

A. Product Data: Submit manufacturers catalog literature for each product required.

B. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

C. Samples: Submit two tags, labels, pipe markers suitably sized for the project.

D. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.3 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.4 QUALITY ASSURANCE

A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

B. Maintain one copy of each document on site.

1.5 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.6 EXTRA MATERIALS

A. Furnish six containers of spray-on adhesive.

PART 2 PRODUCTS

2.1 NAMEPLATES

A. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.2 TAGS

A. Plastic Tags:
   1. Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 38 mm square.

B. Metal Tags:
   1. Brass with stamped letters; tag size minimum 38 mm square with finished edges.

C. Information Tags:
   1. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 83 x 143 mm with grommet and self-locking nylon ties.

D. Tag Chart: Typewritten letter size list of applied tags and location in anodized aluminum frame.

2.3 STENCILS

A. Stencils: With clean cut symbols and letters of following size:
   1. Up to 51 mm Outside Diameter of Insulation or Pipe: 13 mm high letters.
   2. 64-150 mm Outside Diameter of Insulation or Pipe: 25-mm high letters.
   3. Over 150 mm Outside Diameter of Insulation or Pipe: 44 mm high letters.
   4. Ductwork and Equipment: 44 mm high letters.

B. Stencil Paint: As specified in Section 09900, semi-gloss enamel, colors and lettering size conforming to ASME A13.1.

2.4 PIPE MARKERS

A. Color and Lettering: Conform to ASME A13.1.

B. Plastic Pipe Markers:
   1. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

C. Plastic Tape Pipe Markers:
   1. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

D. Plastic Underground Pipe Markers:
   1. Bright colored continuously printed plastic ribbon tape, minimum 150 mm wide by 0.10 mm thick, manufactured for direct burial service.

2.5 CEILING TACKS

A. Description: Steel with 19 mm diameter color-coded head.

B. Color code as follows:
   1. HVAC equipment: Yellow.
   2. Fire dampers/smoke dampers: Red.
   3. Plumbing valves: Green.
   4. Heating/cooling valves: Blue.

2.6 LABELS

A. Description: Aluminum, size 48 x 19 mm, adhesive backed with printed identification and bar code.

2.7 LOCKOUT DEVICES

A. Lockout Hasps:
   1. Anodized aluminum hasp with erasable label surface; size minimum 184 x 76 mm.

B. Valve Lockout Devices:
   1. Steel device preventing access to valve operator, accepting lock shackle.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Section 09900 for stencil painting.

3.2 INSTALLATION

A. Install identifying devices after completion of coverings and painting.

B. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.

C. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.

D. Install tags using corrosion resistant chain. Number tags consecutively by location.

E. Install underground plastic pipe markers 150 to 200 mm below finished grade, directly above buried pipe.

F. Install piping identification on chilled and heating water pipes.

G. Identify chiller, boiler, fan coil units air handling units, pumps, tanks, and fans with plastic nameplates.

H. Identify control panels and major control components outside panels with plastic nameplates.

I. Identify valves in main and branch piping with tags.

J. Identify air terminal units with numbered tags.

K. Tag automatic controls, instruments, and relays. Key to control schematic.

L. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 20 mm diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 6 m on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

M. Identify ductwork with plastic nameplates. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

N. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION 15075

SECTION 15120

PIPING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pressure gages.
2. Pressure gage taps.
3. Thermometers.
4. Thermometer supports.
5. Test plugs.
6. Static pressure gages.
7. Flexible connectors.
8. Diaphragm-type expansion tanks.
9. Air vents.
10. Air separators.
11. Strainers.
12. Flow controls.
13. Relief valves.

1.2 PERFORMANCE REQUIREMENTS

A. Flexible Connectors: Provide at or near pumps, compressors and motorized equipment where piping configuration does not absorb vibration.

1.3 SUBMITTALS

A. Product Data: Submit for manufactured products and assemblies used in this Project.
1. Manufacturer’s data and list indicating use, operating range, total range, accuracy, and location for manufactured components.
2. Submit product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each piping specialty.
4. Submit electrical characteristics and connection requirements.

B. Samples: Submit one unit of each of the above mentioned piping specialties.

C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures, application, selection, and hookup configuration. Include pipe and accessory elevations.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of actual locations of components and instrumentation.

B. Operation and Maintenance Data: Submit instructions for calibrating instruments, installation instructions, assembly views, servicing requirements, lubrication instruction, and replacement parts list.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept piping specialties on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Protect systems from entry of foreign materials by temporary covers, caps and closures, completing sections of the work, and isolating parts of completed system until installation.

1.6 FIELD MEASUREMENTS

A. Verify field measurements before fabrication.

PART 2 PRODUCTS

2.1 PRESSURE GAGES

A. Gage: ASME B40.1, UL 393 with bourdon tube, rotary brass movement, brass socket, front calibration adjustment, black scale on white background.
   1. Case: Stainless steel.
   2. Bourdon Tube: Type 316 stainless steel.
   3. Dial Size: 102 mm diameter.
   4. Mid-Scale Accuracy: 1/2 percent.
   5. Scale: Bar
   6. Dial: Glycerin submerged.

2.2 PRESSURE GAGE TAPS

A. Needle Valve: Stainless Steel, 6 mm NPT for minimum 2070 kPa.

2.3 STEM TYPE THERMOMETERS

A. Thermometer: ASTM E1, red or blue appearing mercury, lens front tube, cast aluminum case with enamel finish.
   1. Size: 178 mm scale.
   2. Window: Clear Lexan.
   3. Stem: Brass, 20 mm NPT, 89 mm long.
   4. Accuracy: ASTM E77 2 percent.
   5. Calibration: Degrees C.
   6. Range: Select to suit application with average reading in the middle.

2.4 THERMOMETER SUPPORTS

A. Socket: Brass separable sockets for thermometer stems with or without extensions, and with cap and chain.

B. Flange: 76 mm outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.5 TEST PLUGS

A. 6 mm NPT or 13 mm NPT stainless steel fitting and cap for receiving 3 mm outside diameter pressure or temperature probe with:
   1. Neoprene core for temperatures up to 93 degrees C.
   2. Nordel core for temperatures up to 176 degrees C.
   3. Viton core for temperatures up to 204 degrees C.

B. Test Kit:
   1. Carrying case, internally padded and fitted containing:
      a. Two 89 mm diameter pressure gages.
         1) Scale range: 0 to 15 Bar
      b. Two gage adapters with 3 mm probes.
      c. Two 200 mm dial thermometers.
         1) Scale range:0 to 50degrees C.
         2) Scale range: 0 to 100 degrees C.

2.6 STATIC PRESSURE GAGES

A. Dial Gages: 89 mm diameter dial in metal case, diaphragm actuated, black figures on white background, front calibration adjustment, 2 percent of full scale accuracy.

B. Inclined Manometer: Plastic with red liquid on white background with black figures, front calibration adjustment, 3 percent of full scale accuracy.

C. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 6 mm diameter tubing.

2.7 FLEXIBLE CONNECTORS

A. Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 230 mm long; for maximum working pressure 2070 kPa. Threaded ends for sizes up to 50 mm diameter and flanged ends for sizes 65 mm diameter and larger.

2.8 DIAPHRAGM-TYPE EXPANSION TANKS

A. Construction: Welded steel, tested and stamped in accordance with ASME Section VIII; supplied with National Board Form U-1, rated for working pressure of 1600 kPa , with flexible EPDM diaphragm sealed into tank, and steel support stand.

B. Accessories: Pressure gage and air-charging fitting, tank drain; pre-charge to 80 kPa.

2.9 AIR VENTS

A. Float Type:
   1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.

2.10 AIR SEPARATORS

A. In-line Air Separators: Cylindrical micro bubble deaerator for removing air from closed type water circuits of cooling and heating. The unit shall have internal copper mesh to change turbulent flow into laminar flow. Body made of Brass for sizes 40 mm and smaller, or steel for sizes 50 mm and larger; tested and stamped for 1000 kPa operating pressure. Temperature range 0-100°C. Flow speed 0-2 m/s. Furnish automatic air vent of brass construction with non-shutoff valve fixed on top of unit.

2.11 STRAINERS

A. Size 50 mm and Smaller:
   1. Screwed brass or iron body for 1600 kPa working pressure, Y pattern with 0.8 mm stainless steel perforated screen.

B. Size 65 mm to 100 mm :
   1. Flanged iron body for 1600 kPa working pressure, Y pattern with 1.2 mm stainless steel perforated screen.

C. Size 125 mm and Larger:
   1. Flanged iron body for 1600 kPa working pressure, basket pattern with 3.2 mm stainless steel perforated screen.

2.12 FLOW CONTROLS

A. Double Regulating Valve (DRV) **<** 50mm.
Body shall be made of Bronze to BS1400LG2 and/or DZR to BS 5154 Alloy B, Double Regulating Valve shall have measuring points of self-sealed and Removable cap. Female threaded ends to BS 21 (ISO 7), DRV shall be of Y Pattern Globe Type with Characterized Throttling Disk.Memory Lock by Allen Key, Pressure Rated PN20 from -20°C to 120°C.
Valve shall be selected so as to give ±6% accuracy (or better). Balancing procedure error should not exceed ±10% of the designed flow.

B. Double Regulating Valve (DRV) **>** 65mm.
Body shall be Made of Cast Iron to BS2789 (EN-GJL-250) or of Ductile iron to BS 2789 Gr 500/7 (EN-GJS-450-10) , Double Regulating Valve shall have measuring points of self-sealed and Removable cap, Grooved ends to ISO 4200, DRV shall be of Y Pattern Globe Valve with Characterized Throttling Disk., Memory Lock by Allen Key. Pressure Rated PN16 from -20°C to 120°C .

Valve shall be selected so as to give ±5% accuracy (or better). Balancing procedure error should not exceed ±10% of the designed flow.

C. Differential Pressure Valve (DPV)**<** 50mm.

Body shall be made of Bronze to BS1400LG2 and/or DZR to BS 5154 Alloy B, Differential Pressure Controller Valve shall have measuring points of self-sealed and Removable cap. Female threaded ends to BS 21 (ISO 7),setting shall be made by Allen Key with shut off capability , Pressure Rated PN16 from -20°C to 120°C .

Minimum Primary Differential Pressure 250 kPa.

DPV shall be selected so as to maximize the 2-way Control valve Authority, with minimum pressure drop, to give the design flow, and to deliver the actual Differential pressure to the Unit or group of Units.

When DPV is to control group of Units (branch connection) DPV shall be connected on the return line, DRV on the supply line, with capillary tube connected to the DRV, Connection of the capillary tube shall be on the primary or secondary (Before or after the DRV), according to the required Differential Pressure, Design Flow and selected DPV.

Size, place and number of DPV's to be used in the control of group of Units (branch connection) depends on the actual coil and 2-way control valve pressure drop.

When DPV is to control one Unit (Control Valve connection) DP shall be connected on the return line, DRV on the return line, 2-way Control Valve in between with capillary tube connected to the DRV, Connection of the capillary tube shall be on the primary or secondary (Before or after the DRV), according to the required Differential Pressure and selected DPV.

D. Differential Pressure Valve (DPV)**>** 65mm.

Body shall be Made of Cast Iron to BS2789 (EN-GJL-250), Differential Pressure Controller Valve shall have measuring points of self-sealed and Removable cap, Flanged to Flanges to BS EN 1092-2, Pressure Rated PN16from -10°C to 80°C .

Minimum Primary Differential Pressure 350 kPa.

DPV shall be selected so as to maximize the 2-way Control valve Authority, with minimum pressure drop, to give the design flow, and to deliver the actual Differential pressure to the Unit or group of Units.

When DPV is to control group of Units (branch connection) DPV shall be connected on the return line, DRV on the supply line, with capillary tube connected to the DRV, Connection of the capillary tube shall on the primary or secondary (Before or after the DRV), according to the required Differential Pressure, Design flow and selected DPV.

Size, place and number of DPV's to be used in the control of group of Units (branch connection) depends on the actual coil and 2-way control valve pressure drop.

When DPV is to control one Unit (Control Valve connection) DPV shall be connected on the return line, DRV on the return line, 2-way Control Valve in between with capillary tube connected to the DRV, Connection of the capillary tube shall be on the primary or secondary (Before or after the DRV), according to the required Differential Pressure and selected DPV.

2.13 RELIEF VALVES

A. Bronze body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated capacities ASME certified and labeled.

PART 3 EXECUTION

3.1 INSTALLATION - THERMOMETERS AND GAGES

A. Install two pressure gage for each pump, locate taps before strainers and on suction and discharge of pump; pipe to gage.

B. Install gage taps in piping

C. Install pressure gages with pulsation dampers. Provide ball valve to isolate each gage. Install siphon on gages in steam systems. Extend nipples and siphons to allow clearance from insulation.

D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 65 mm for installation of thermometer sockets. Allow clearance from insulation.

E. Install thermometers in air duct systems on flanges.

F. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets. Where thermometers are provided on local panels, duct or pipe mounted thermometers are not required.

G. Locate duct-mounted thermometers minimum 3 m downstream of mixing-dampers, coils, or other devices causing air turbulence.

H. Coil and conceal excess capillary on remote element instruments.

I. Install static pressure gages to measure across filters and filter banks, (inlet to outlet). On multiple banks, provide manifold and single gage.

J. Provide instruments with scale ranges selected according to service with largest appropriate scale.

K. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

L. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.2 INSTALLATION - HYDRONIC PIPING SPECIALTIES

A. Locate test plugs as indicated on Drawings.

B. Where large air quantities accumulate, provide enlarged air collection standpipes.

C. Install manual air vents at system high points.

D. For automatic air vents in ceiling spaces or other concealed locations, install vent tubing to nearest drain.

E. Provide air separator at the inlet to chillers and outlet from boilers.

F. Provide drain and hose connection with valve on strainer blow down connection.

G. Support pump fittings with floor mounted pipe and flange supports.

H. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.

I. Select system relief valve capacity greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

J. Pipe relief valve outlet to nearest floor drain.

K. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

END OF SECTION 15120

SECTION 15739

SPLIT SYSTEM AIR CONDITIONING UNITS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Indoor unit (indoor unit).
   2. Condensing unit. (outdoor unit)

1.2 SUBMITTALS

A. Product Data: Submit data indicating:
   1. Cooling and heating capacities.
   2. Dimensions.
   3. Weights.
   4. Rough-in connections and connection requirements.
   5. Electrical requirements with electrical characteristics and connection requirements.
   6. Controls.
   7. Accessories.

B. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

C. Manufacturer's Certificate: Certify Products to meet specified requirements.

D. Manufacturer’s Field Reports: Submit start-up report for each unit.

1.3 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of controls installed remotely from units.

B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.4 QUALITY ASSURANCE

A. Performance Requirements:, Energy Efficiency Rating (EER) not less than prescribed by ASHRAE 90.1 when used in combination with compressors and evaporator coils when tested in accordance with ARI 210/240.

B. Cooling Capacity: Rate in accordance with ARI 210/240.

C. Sound Rating: Measure in accordance with ARI 270.

D. Insulation and adhesives: Meet requirements of NFPA 90A.

E. Maintain two copies of each document on site.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.

B. Comply with manufacturer's installation instruction for rigging, unloading and transporting units.

C. Protect units from weather and construction traffic by storing in dry, roofed location.

1.6 COORDINATION

A. Coordinate installation of condensing units with concrete pad and roof structure.

B. Coordinate installation of air handling units with building structure.

1.7 GUARANTEE:

Split Air conditioning units shall be the latest and newest model and latest technology for the manufacturer products and shall include a two years full guarantee, full warranty and full preventive maintenance on all parts and labor after acceptance by the Engineer and the owner including cleaning ,washing filters and outdoors condensers with water four times a year .(cost of spare parts ,labor and regular visits and upon request deemed to be included in the contractor's cost for the two years after acceptance) .

Split Air conditioning units shall have a VALID EUROVENT CERTIFICATION.

PART 2 PRODUCTS

2.1 SPLIT SYSTEM AIR CONDITIONING UNITS (SACU)

A. Product Description:**Split system, heat pump inverter controlled type** to be suitable for operation from **-5°C ambient temperature up to 46°C ambient temperature** , consisting of indoor air handling unit and outdoor condensing unit including cabinet, evaporator fan, refrigerant cooling coil, compressor, refrigeration circuit, condenser, electric heating coil, air filters, thermostat and controls, air handling unit accessories, condensing unit accessories, refrigeration specialties, and inter connecting refrigerant piping between indoor and outdoor units including thermal insulation, control wiring and power cables.

B. All outdoor units shall have a **VALID EUROVENT CERTIFICATION WITH SEASONAL ENERGY EFFECIENCY RATIO (SEER) NOT LESS THAN 6.5**.

2.2 CONDENSING UNIT (CU)

A. General: Factory assembled and tested air cooled condensing units, consisting of casing, compressors, condensers, coils, condenser fans and motors, and unit controls.

B. Unit Casings: Exposed casing surfaces constructed of galvanized steel with manufacturer's standard baked enamel finish. Designed for outdoor installation and complete with weather protection for components and controls, and complete with removable panels for required access to compressors, controls, condenser fans, motors, and drives.

C. Compressor: Single refrigeration circuit with inverter controlled compressors, resiliently mounted, with positive lubrication, and internal motor overload protection.

D. Condenser Coil: Constructed of copper tubing mechanically bonded to aluminum fins, factory leak and pressure tested.

E. Controls: Furnish operating and safety controls including high and low pressure cutouts. Control transformer. Furnish magnetic contactors for compressor and condenser fan motors.

F. Condenser Fans and Drives: Direct drive propeller fans statically and dynamically balanced. Wired to operate with compressor. Permanently lubricated ball bearing type motors with built-in thermal overload protection. Furnish high efficiency fan motors.

G. Condensing Unit Accessories: Furnish the following accessories:
1. Controls to provide freeze protection on evaporator.
2. Time delay relay.
3. Anti-short cycle timer.
4. Disconnect switch.
5. Vibration isolators of neoprene rubber.
6. Condenser Coil Guard: Condenser fan openings furnished with PVC coated steel wire safety guards.

H. Refrigeration specialties: Furnish the following for each circuit:
1. Charge of compressor oil.
2. Full charge of refrigerant.
3. Shut-off valves on suction and liquid piping.
4. Charging valve.
5. Crankcase heater.
6. Hot gas muffler.
7. Pressure relief device.

I. Refrigerant: Furnish full charge of refrigerant R-410A or R-32

J. Shall have Eerovent Certification.

2.3 CONTROLS

A. Thermostat: Remote space thermostat with single stage cooling and heating.

2.4 Medium & High static pressure Ducted Concealed

A. Indoor Units shall be Concealed ducted type, OR as indicated on drawings, consisting of DX coil, fans, high Efficiency electric motor, condensate drain pan with drain connection, galvanized steel casing panels, filter, electric junction box and fan switch.

B. Evaporator Fans: Non-overloading type directly connected to fan motor, statically and dynamically balanced and designed for whisper quiet operation. Materials are to be high strength and corrosion resistant.

C. Evaporator Fan Motor: DC Inverter, Shaded pole, to ensure an optimum comfort level and energy saving, with built in thermal overload protection and bronze sleeve type bearings with oil reservoirs. Motor to be resiliently mounted.

D. Evaporator Condensate Drain Pan: projected under entire length and width of coil including headers and return bends, valves and fittings. Pan is to be treated against corrosion, insulated and pitched for positive drainage and unit installed level.

E. Indoor unit to be provided with built-in drain pump with at least 600 mm head and a non-return check valve and to be installed inside the FCU structure.

F. Indoor unit to be with a flexible connection hose compatible to connect with PVC drain pipes and Schrader Shut of valves on suction and liquid piping for each Indoor unit.

G. Room thermostat with the following features :

- Operating mode button & display (Cool, Dry, Fan, Heat)
- Fan control (Auto high, medium and low speed selector & display
- ON/OFF button
- Set point Temperature
- Room Temperature
- Timer button & display
- Sleep button & display
- Swing control & display
- Child lock function
- Clear LCD display

H. Indoor and outdoor units shall be fully controlled by Master Centralized Controller of the VRF system threw a network converter supplied be the split unit.

2.5 4-Way Cassette & Mini 4-Way Cassette

1. Modern style, inverter driven extremely quiet in operation, long-life washable filters, vibration free.
2. Cassette type, impact-resistant, washable decoration panel.
3. Air suction through the panel below, which has an integrated, long-life air filter
4. The air is discharged via four outlets with motorized, air vanes, which can be horizontally and vertically adjusted between 0 -90°.
5. Phase controlled multiple steps, vibration-free and quiet running.
6. Protected by a thermal contact.
7. Fan motor thermal protection.
8. Standard built in drain pump of minimum 600mm head.
9. Sound pressure not more than 45 dBA @ high speed.
10. With Heat Pump
11. Out door condensing units.
12. With Wireless remote control.
13. Indoor and outdoor units shall be fully controlled by Master Centralized Controller of the VRF system threw a network converter supplied by the split unit.

2.6 Wall Type

Modern style, extremely quiet in operation, long-life washable filters, vibration free.

1- Wall-mounted, impact-resistant, washable decoration panel.
2- Air suction through the panel, which has an integrated, long-life air filter
3- The air is discharged threw motorized air vanes.
4- Phase controlled multiple steps, vibration-free and quiet running.
5- Protected by a thermal contact.
6- Microprocessor temperature control.
7- Fan motor thermal protection.
8- Sound pressure not more than 45 dBA @ high speed.
9- Built in infra red receiver with Wireless remote control.
10- Indoor and outdoor units shall be fully controlled by Master Centralized Controller of the VRF system threw a network converter supplied by the split unit.

2.7 Floor Type

Modern style, extremely quiet in operation, long-life washable filters, vibration free.

1- Floor-mounted, impact-resistant, washable decoration panel.
2- Air suction through the panel, which has an integrated, long-life air filter
3- The air is discharged threw motorized air vanes.
4- Phase controlled multiple steps, vibration-free and quiet running.

5- Protected by a thermal contact.
6- Microprocessor temperature control.
7- Fan motor thermal protection.
8- Sound pressure not more than 45 dBA @ high speed.
9- Built in infra red receiver with Wireless remote control.
10- Indoor and outdoor units shall be fully controlled by Master Centralized Controller of the VRF system threw a network converter supplied by the split unit.

2.8 Ceiling Type

Modern style, extremely quiet in operation, long-life washable filters, vibration free.
1- Ceiling-mounted, impact-resistant, washable decoration panel.
2- Air suction through the panel, which has an integrated, long-life air filter
3- The air is discharged threw motorized air vanes.
4- Phase controlled multiple steps, vibration-free and quiet running.
5- Protected by a thermal contact.
6- Microprocessor temperature control.
7- Fan motor thermal protection.
8- Sound pressure not more than 45 dBA @ high speed.
9- Built in infra red receiver with Wireless remote control.
10- Indoor and outdoor units shall be fully controlled by Master Centralized Controller of the VRF system threw a network converter supplied by the split unit.
11- Standard built in drain pump of minimum 600mm head

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify concrete pad for condensing unit is ready for unit installation.

3.2 INSTALLATION - CONDENSING UNIT

A. Install condensing units on vibration isolators.

B. Install units on concrete foundations or alternative painted steel base to raise unit 150mm above finished roof level.

C. Install refrigerant piping from unit to condensing unit. Install refrigerant specialties furnished with unit.

D. Evacuate refrigerant piping and install full charge of refrigerant.

E. Install electrical devices furnished loose for field mounting.

F. Install control wiring and cables between air handling unit, condensing unit, and field installed accessories.

G. Install connection to electrical power wiring in accordance with electrical specifications.

3.3 MANUFACTURER'S FIELD SERVICES

A. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout.

3.4 CLEANING

A. Vacuum clean coils and inside of unit cabinet.

B. Install new cleanable filters in units at Substantial Completion.

3.5 DEMONSTRATION

A. Demonstrate A/C split unit operation and maintenance.

B. Demonstrate starting, maintenance, and operation of condensing unit including freeze protection on evaporator.

END OF SECTION 15739

SECTION 15741

VARIABLE REFRIGERANT FLOW (VRF) SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The extent of VRF air-conditioners work is indicated by requirements of this section. Units are hereby defined to include, but not by way of limitation, refrigeration compressors, direct-expansion coils, filters, fans, and air-cooled condensers.

B. The types of air-conditioning units required for project include the following:

1. VRF system

1.02 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of types, sizes and capacities required, whose products have been in satisfactory use in similar service for not less than 10 years.

B. The Agent or Authorized Dealer should be representing directly the manufacturer, a formal letter should be issued in the name of the Agent or Authorized Dealer directly from the manufacturer.

C. The Agent or Authorized Dealer should be registered in Jordan for not less than 5years, and should have experience in selling, installing and maintaining VRF systems in Jordan.

D. the product have been in satisfactory use in similar projects in Jordan for not less than Three years

E. Guarantee: **Air conditioning units shall be the latest and newest model and latest technology for the manufacturer products** and shall include a two years full guarantee, full warranty and full preventive maintenance on all parts and labor after acceptance by the Engineer and the owner including cleaning and washing filters and outdoors condensers with water four times a year .(cost of spare parts ,labor and regular visits and upon request deemed to be included in the contractor's cost for the two years after acceptance) .

F. Instruction of Personnel: At completion of the work, the Contractor shall furnish a competent service man to instruct Client's personnel in the proper operation and maintenance procedures to be followed. The instruction shall be given for a total of five (5) full working days, not including time spent trouble-shooting and adjusting the system as required by this Contract. At Client's option the instruction period may be postponed in part or in whole until a later period within the year following the completion of the Work.

G . All VRF system components shall be manufactured in factories owned by the brand name holder.

1.03 SUBMITTALS

A. Submit manufacturer's data of all air-conditioning units, including drawings showing overall dimensions of unit, operating weights, and auxiliary equipment.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver air conditioning units with factory-installed shipping skids and lifting lugs; pack components in factory-fabricated protective containers.

B. Handle air conditioning units carefully to avoid damage to components, enclosures, and finish. Do not install-damaged components; replace and return damaged components to air conditioning unit manufacturer.

C. Store air conditioning units in clear dry place and protect from weather and construction traffic.

PART 2 - PRODUCTS

2.01 VRF SYSTEM AIR CONDITIONERS

A. Split system Shall be fully automatic Heat pump Cooling/Heating operation consisting of outdoor units (Condensing Units), indoor units (IDU), heat exchangers with DX coil, individual control of multiple indoor units with solenoid valve kit, Control system and interconnecting refrigerant copper pipes.

B. All outdoor units shall have a **VALID EUROVENT CERTIFICATION WITH SEASONAL ENERGY EFFECIENCY RATIO (SEER) NOT LESS THAN 6.5**.

CONDENSING UNIT

A. Condensing Unit: Factory assembled and tested, to be suitable for operation in **43°C ambient temperature** air cooled. comprising compressors, condenser coil, condenser fans and motors, refrigerant receiver, charging valve and controls, assembled in a common casing. Unit to be tested at factory and supplied complete with refrigerant and dehydrated compressor oil.

B. Compressor: Sealed, hermetic type, mounted on external spring isolators, with crankcase heater and built-in thermal overload protection. Operated on environment friendly refrigerant R-410A or R-32.

Compressors in each module shall be scroll or rotary of variable speed operated with DC Inverter technologies.

Each compressor shall have dedicated contactor and overload protection, with oil balancing circuit and refrigerant receiver and accumulator.

C. Condenser Coil: Heavy gauge seamless copper tubes mechanically bonded to aluminum plate fins corrosion protected with protective coating. Condensers shall be pre-coated with a tough abrasion resistant epoxy coating; it is to be circuited for sub-cooling.

D. Condenser Fan and Motor: Fan to be propeller type, weatherproofed, statically and dynamically balanced, directly driven by a totally enclosed, permanently lubricated, resiliently mounted electric motor, with Class F insulation and in-built thermal overload protection.

E. Condensing Unit Casing shall be fully weatherproofed for outdoor installation. Casing is to have openings for power and refrigerant connections and removable panels for easy access to internal components. Control panel is to have a hinged access door.
Front panel is to have a quick access panel for measurement purposes.
Casing base shall be suitably designed for lifting purposes

F. Condensing Unit and indoor units shall be equipped with a software with feature (ignore error) that provide a non-Stop operation in case of failure for any numbers of indoor units such as errors or electrical power cutoff, condensing unit and related indoor units can keep operating.

G. Condensing Unit Controls: To be factory wired and tested. They are to include high- and low-pressure switches, compressor overload device, positive acting timer to prevent short cycling of compressor on power interruption, crankcase heater, condenser fan contactors, circuit breakers, time delay relay. Anti-short cycle timer, phase failure& phase reversal protection relay, and single-phase protection relay.

Should include microprocessor controller

Should include electrical components for maintenance, operations and safety of the unit.

Should be provided with all needed gauges and sensors.

Suitable to interface with checks, high level controllers, and billing system.

Should have simple emergency stop function and pump down function with ability to keep part of the refrigerant inside the compressor.

The outdoor unit should have a function of auto detection of the indoor unit on the system data loop control bus.

H. The following specialties shall be furnished for each refrigerant circuit
- Full charge of compressor oil.
- Full charge of refrigerant.
- Pressure relief devices.
- Low- and high-pressure cutouts.
- Refrigerant suction temp sensor.
- Temperature sensors of oil.

INDOOR UNITS (IDU)

1. Fan coil units(High & Medium Static)

A. Indoor Units: shall be Concealed ducted type, OR as indicated on drawings.

B. Evaporator Unit is to consist of DX coil, fans and high Efficiency electric motor, condensate drain pan with drain connection, galvanized steel casing panels, filter, electric junction box and fan switch.

C. Evaporator Coil: Staggered 12 mm O.D. heavy wall seamless copper tubes mechanically bonded to aluminum fins, with 16 mm solder joint copper tube connections and manual air vent. Coil is to be leak tested at factory to 2352 KPa minimum air pressure under water.

D. Evaporator Unit Casing: Decorative type, 18-gauge galvanized steel sheet braced and reinforced for maximum rigidity, thermally and acoustically insulated with fiberglass blankets fastened with waterproof adhesive.

E. Evaporator Fans: non-overloading type, directly connected to fan motor, statically and dynamically balanced and designed for whisper quiet operation. Materials are to be high strength and corrosion resistant.

F. Evaporator Motor: DC Motor, with built in thermal overload protection and bronze sleeve type bearings with oil reservoirs. Motor to be resiliently mounted.

G. Evaporator Condensate Drain Pan: projected under entire length and width of coil including headers and return bends, valves and fittings. Pan is to be treated against corrosion, insulated and pitched for positive drainage and unit installed level.

H. Indoor unit to be provided with built-in drain pump with at least 650 mm head and a non-return check valve.

I. FCU should come with a flexible connection hose compatible to connect with PVC drain pipes and shut of valves on suction and liquid piping for each FCU

J. Microprocessor controller: to be furnished to achieve the following.
-Close control room temperature for cooling and heating.
- Individual room wire thermostat for each indoor unit fully synchronized with the outdoor unit.
- Fan operation
- Communication with zone master controller.
- Should be able to interface with different types of sensors such as temperature and humidity
- Function to interpolate between room temperature and on coil temperature using temperature sensor measurement.

K. Decorative External Room Temperature sensor.

2. 4-Way Cassette & Mini 4-Way Cassette

Modern style, extremely quiet in operation, long-life washable filters, vibration free. Electronic expansion valve with stepping motor, adjustment between 0% - 100%.

1- Ceiling-mounted, impact-resistant, washable decoration panel with one size for all units according to the tender drawings.
2- Four-way air flow discharge ensures uniform air flow and temperature distribution.
3- Air suction through the panel below, which has an integrated, long-life air filter
4- The air is discharged via four outlets with motorized, air vanes, which can be horizontally and vertically adjusted between 0 -90°.
5- Phase controlled multiple steps, vibration-free and quiet running.

6- Protected by a thermal contact.
7- Microprocessor temperature control.
8- Fan motor thermal protection.
9- Standard built in drain pump of minimum 600mm head.
10- Sound pressure not more than 45 dBA @ high speed.
11- Built in infrared receiver with Wireless remote control.
12- Decorative External Room Temperature sensor.
Face cover shall be one size for all units in all cooling capacities.

3. 2-Way Cassette

Modern style, extremely quiet in operation, long-life washable filters, vibration free. Electronic expansion valve with stepping motor, adjustment between 0% - 100%.

1- Ceiling-mounted, impact-resistant, washable decoration panel with one size for all units according to tender drawings.
2- Two-way air flow discharge ensures uniform air flow and temperature distribution.
3- Air suction through the panel below, which has an integrated, long-life air filter
4- The air is discharged via four outlets with motorized, air vanes, which can be horizontally and vertically adjusted between 0 -90°.
5- Phase controlled multiple steps, vibration-free and quiet running.
6- Protected by a thermal contact.
7- Microprocessor temperature control.
8- Fan motor thermal protection.
9- Standard built in drain pump of minimum 600mm head.
10- Sound pressure not more than 45 dBA @ high speed.
11- Built in infrared receiver with Wireless remote control.
12- Face cover shall be one size for all units in all cooling capacities.
13- Decorative External Room Temperature sensor.

4. Wall Mounted Type

Modern style, extremely quiet in operation, long-life washable filters, vibration free. Electronic expansion valve with stepping motor, adjustment between 0%-100%.

1- wall-mounted, impact-resistant, washable decoration panel.
2- Air suction through the panel, which has an integrated, long-life air filter
3- The air is discharged threw motorized air vanes.
4- Phase controlled multiple steps, vibration-free and quiet running.
5- Protected by a thermal contact.
6- Microprocessor temperature control.
7- Fan motor thermal protection.
8- Sound pressure not more than 45 dBA @ high speed.
9- Built in infra-red receiver with Wireless remote control
10- Decorative External Room Temperature sensor.

5. Floor mounted type

Modern style, extremely quiet in operation, long-life washable filters, vibration free. Electronic expansion valve with stepping motor, adjustment between 0% - 100%.

1- floor-mounted, impact-resistant, washable decoration panel.
2- Air suction through the panel, which has an integrated, long-life air filter
3- The air is discharged threw motorized air vanes.

4- Phase controlled multiple steps, vibration-free and quiet running.
5- Protected by a thermal contact.
6- Microprocessor temperature control.
7- Fan motor thermal protection.
8- Sound pressure not more than 45dBA @ high speed.
9- Built in infrared receiver with Wireless remote control
10- Decorative External Room Temperature sensor.

6. Ceiling mounted type

Modern style, extremely quiet in operation, long-life washable filters, vibration free. Electronic expansion valve with stepping motor, adjustment between 0% - 100%.
1- ceiling-mounted, impact-resistant, washable decoration panel.
2- Air suction through the panel, which has an integrated, long-life air filter
3- The air is discharged threw motorized air vanes.
4- Phase controlled multiple steps, vibration-free and quiet running.
5- Protected by a thermal contact.
6- Microprocessor temperature control.
7- Fan motor thermal protection.
8- Sound pressure not more than 45dBA @ high speed.
9- Standard built in drain pump of minimum 600mm head.
10- Built in infrared receiver with Wireless remote control
11- Decorative External Room Temperature sensor.

Master Centralized Controller

Furnish centralized controller with built-in web server software for the whole VRF system to perform and control the following functions and features: -

1. Daily and weekly scheduling programming for the whole system operation hours.
2. colored LCD touch panel.
3. Password security enabled.
4. Time zone and calendar.
5. Enable switching between heating & cooling manually& automatically.
6. Enable automatically & manually controlling and monitoring all indoor units for: -
   A-Set &Room Temperature
   B- Fan speed
   C- Swing
   D- Error codes
   E- All schedules.
7. Additional digital input /output device available.
8. Should have a built in RJ input in the same structure of the master centralized controller which will allow the VRF system to be controlled remotely and directly via local intranet network through local IP address and also to be controlled remotely and directly via internet through public IP address.

9. All menu's content and controls in the master centralized controller software should appear on the internet web page.
10- Third party web page or software connection through internet will not be allowed.
11. Provide a lockable galvanized metal enamel painted to put the master centralized controller inside it.
12. Shall have interface for connection with the BMS.

REFRIGERANT PIPING

A. Furnish complete copper pipes type K or L.
B. Brazing copper joint fittings shall be used to join the pipes and shall be performed by passing inert gas (Nitrogen), bending the pipes not allowed.
C. Refrigerant pipes Insulation shall be 19 mm thick for all pipes run indoor and outdoor made of flexible elastomeric, closed cell expanded rubber density 65-80kg/m^3.
D. All insulated pipes on roof and exposed to sun and weather condition shall be enclosed within heavy duty galvanized steel trunk and support provided with 2 mm thickness galvanized cover.
E. Coiled copper pipes are only allowed between the shutoff valves and the indoor units for all copper sizes.
F. Copper Collector headers are not allowed only Copper Refnet joints allowed.
G. Separate insulations, wrapping tape and Separate supports for liquid pipes and gas pipes.
H. Schrader Shut of valves on gas and liquid piping for each module and to be installed Outside the module in addition to the built-in valves inside the module which Come from the factory.
I. Schrader Shut of valves on gas and liquid piping for each indoor unit.

OPERATING RANGE

A-Running condition of cooling Mode: outdoor temperature **(-5C) to (43C)**
B-running condition of heating Mode: outdoor temperature **(-20C) to (15C).**

PART 3 - EXECUTION

3.01 INSPECTION

A. Contractor shall examine areas and conditions under which air-conditioning units are to be installed and notify the Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

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3.02 GROUNDING

A. Provide positive equipment ground for self-contained air-conditioning unit components.

3.04 TESTING

A. Upon completion of installation air conditioners, start-up and test equipment in accordance with AHRI standards, or equivalent BS standard, operate units to demonstrate capability and compliance with requirements. Where possible, field-correct malfunctioning units, then retest to demonstrate compliance.

** END OF SECTION **

SECTION 15810

DUCTWORK

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: rectangular and round metal ducts and plenums for heating, ventilating and air conditioning system.
   1. Sheet metal materials
   2. Pre-insulated ductwork
   3. Rectangular ducts and fittings fabrication.
   4. Sealants and gaskets.
   5. Hangers and supports.
   6. Seismic-restraint devices.
   7. Flexible connectors.
   8. Flexible ducts.
   9. Duct access doors, panels & sections.
   10. Instrument test fittings.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

1.4 SUBMITTALS

A. Product Data: For each type of the following products:
   1. Liners and adhesives.
   2. Sealants and gaskets.
   3. Seismic-restraint devices.

B. Shop Drawings:
   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   2. Factory- and shop-fabricated ducts and fittings.

3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
13. Coordination with ceiling mounted items, including lighting fixtures, diffusers, grilles, speakers, sprinkler heads, access panels and special moldings.

C. Welding certificates.

D. Field quality-control reports.

E. Fan head calculations based on ductwork shop drawings.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver sealant and firestopping materials to site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.

B. Store and handle sealant and firestopping materials according to manufacturer's written recommendations.

PART 2 PRODUCTS

2.1 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M, G90 (Z 275) coating designation, mill-phosphatized finish for surfaces of ducts exposed to view.

C. Reinforced Shapes and Plates: galvanized steel reinforcement on galvanized sheet metal ducts; compatible material for aluminum and stainless-steel ducts.

D. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, cold rolled sheets, commercial quality, with oiled, matte finish for exposed ducts.

E. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Surface finish to be No. 4 for ducts exposed to view, and No. 1 for concealed ducts.

F. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

G. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless steel ducts.

H. Tie Rods: Galvanized steel, 6mm minimum diameter for lengths 900mm or less; 10mm minimum diameter for lengths longer than 900mm.

2.2 PRE-INSULATED DUCTWORK

A. For indoor installation

Ductworks shall be fabricated using the aluminumpolyisocyanurate closed cell foam sandwich panels composed of an expanded foam faced on both sides with two embossed aluminum foils 80 micro, embossed aluminum foil with epoxy coating for external foil and antibacterial epoxy coated aluminum for internal foil to kill germs and prevent air pollution within the duct.

The close cell rigid foam shall be 20mm thick, with a density of 45-50kg/m3 and an initial thermal conductivity of 0,020-0.023 W/mk and water absorption of 0.9g/100cm^2 and temperature range of -170 up to 140 ^{o}C.

The ducts shall be fabricated and supported in compliance with the manufacturer instructions.

B. For outdoor installation

Pre-insulated ductworks must be fabricated using the aluminum polyisocyanurate closed cell foam sandwich panels composed of an expanded foam faced on both sides with embossed aluminum foils, 200 micron aluminum foil with epoxy coating for external side and antibacterial epoxy coated 80 micron aluminum for internal side to kill germs and prevent air pollution within the duct.

The close cell rigid foam shall be 30mm thick, with a density of 45-50kg/m3 and an initial thermal conductivity of 0,020-0.023 W/mk and water absorption of 0.9g/100cm^2 and temperature range of -170 up to 140 ^{o}C.

The ducts shall be fabricated and supported in compliance with the manufacturer instructions.

A. Application

The pre-insulated duct work shall be used only for insulated duct work (treated fresh air, AC supply and return duct work). No external thermal insulation is needed.

2.3 RECTANGULAR DUCTS AND FITTINGS FABRICATION

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated. Comply with requirements for metal thickness, reinforcing types and intervals, tie-rod applications and joints types and intervals.

2.4 DUCT FIRE PROTECTION

A. All ducts when specified to be fire rated, shall be protected by a fire proof product to withstand 400◦C temperature for two hours.

2.5 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Fire Resistant Sealing Materials.
   1. Sealing materials shall be silicone based formulated for use in through-penetration fire-stopping around pipes and duct penetrations through fire-rated walls and floors. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with ASTM E814, by Underwriters' Laboratories, Inc., or other testing and inspection agency acceptable to authorities having jurisdiction.
   2. Sealant
      a. Provide ready-to-use silicone penetration seal that will stop passage of fire, smoke, and water through fire-rated wall and floor penetrations and will cure in the presence of atmospheric moisture to produce durable and flexible seal, and will form airtight and watertight bonds with most common building materials in any combination including cement, masonry, steel, and aluminum.
      b. Sealant Composition shall be one-part ready-to-use materials with consistency of soft caulk at temperatures ranging from -35 to 160 F, and extension and compression properties of plus/minus 40% of original gap.
   3. Foam

C. Provide "free foam" density, two-part silicone elastomer, supplied in liquid components with easy identification.

2.6 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Electrogalvanized steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electro-galvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1 (Table 4-1M), "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.7 SEISMIC-RESTRAINT DEVICES

A. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

B. Restraint Cables: ASTM A 603, galvanized-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.

C. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod.

2.8 FLEXIBLE CONNECTORS

A. General: Flexible connectors shall be provided on fan inlet and outlet connections. They shall be of the full cross sectional area of the matching fan inlet or outlet or duct section. The ends of the ducts and for connection shall be in line.

B. Flame retardant or non combustible fabrics fabricated from chemically impregnated canvas.

C. Conventional indoor system flexible connector: Glass fabric double coated.

D. Conventional outdoor system flexible connector: Glass fabric double coated with weatherproof coating resistant to sun UV rays.

2.9 FLEXIBLE DUCTS

A. General: Comply with UL 181, Class 1.

B. Flexible Ducts, Uninsulated: Spiral-wound steel spring with flameproof vinyl sheathing.

C. Flexible Ducts, Insulated: Factory-fabricated, insulated, round duct, with an outer jacket enclosing 1-1/2-inch-(38mm-) thick, glass-fiber insulation around a continuous inner liner.

1. Reinforcement: Steel-wire helix encapsulated in inner liner.
2. Outer Jacket: Glass-reinforced, silver Mylar with a continuous hanging tab, integral fibrous-glass tape, and nylon hanging cord.
3. Inner liner: Polyethylene film.

D. Pressure rating: 6 inch wg (1500 Pa) positive, ½-inch wg (125 Pa) negative.

2.10 DUCT ACCESS DOORS, PANELS AND SECTIONS

2.10 Provide access doors, sized and located for maintenance work, upstream, in the following locations:

1. Each duct mounted coil and humidifier.
2. Each fire damper (for link service), smoke damper and automatic control damper.
3. Each duct mounted smoke detector.
4. For cleaning operating room supply air duct and kitchen hood exhaust duct, locate access doors at 6 m (20 feet) intervals and at each change in duct direction.

2.11 Openings shall be as large as feasible in small ducts, 300 mm by 300 mm (12 inch by 12 inch) minimum where possible. Access sections in insulated ducts shall be double-wall, insulated. Transparent shatterproof covers are preferred for uninsulated ducts.

1. For rectangular ducts: Refer to SMACNA Standards.
2. For round and flat oval duct: Access sections shall be not less than 1.0 mm (20 gage) housing welded or riveted to a duct section.

2.11 INSTRUMENT TEST FITTINGS

PART 3 Manufactured type with a minimum 50 mm (two inch) length for insulated duct, and a minimum 25 mm (one inch) length for duct not insulated. Test hole shall have a flat gasket for rectangular ducts and a concave gasket for round ducts at the base, and a screw cap to prevent air leakage.

PART 4 Provide instrument test holes at each duct or casing mounted temperature sensor or transmitter, and at entering and leaving side of each heating coil, cooling coil, and heat recovery unit.

PART 5 EXECUTION

5.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round and flat-oval ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 15 Section "Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

5.2 SEISMIC-RESTRAINT-DEVICE INSTALLATION

1. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

2. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

3. Install cables so they do not bend across edges of adjacent equipment or building structure.

4. Install cable restraints on ducts that are suspended with vibration isolators.

5.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:
   1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual."
   2. Test the following systems:
      a. Supply air applied to pressure ducts of (750Pa) and higher.
   3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
   4. Test for leaks before insulation application.
   5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.

C. Duct System Cleanliness Tests:
   Visually inspect duct system to ensure that no visible contaminants are present.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports containing the quantity of each inspection on the executed ductworks and its related accessories.

5.4 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.

5.5 CLEANING NEW SYSTEMS

A. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.

B. Use service openings, as required, for physical and mechanical entry and for inspection.
   1. Create other openings to comply with duct standards.
   2. Disconnect flexible ducts as needed for cleaning and inspection.
   3. Remove and reinstall ceiling sections to gain access during the cleaning process.

C. Vent vacuuming system to the outside. Include filtration to contain debris removed from HVAC systems, and locate exhaust down wind and away from air intakes and other points of entry into building.

D. Clean the following metal duct systems by removing surface contaminants and deposits:
   1. Air outlets and inlets (registers, grilles, and diffusers).
   2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
   3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
   4. Coils and related components.
   5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
   6. Supply-air ducts, dampers, actuators, and turning vanes.

E. Mechanical Cleaning Methodology:
   1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
   2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
   3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
   4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet.
   5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

F. Cleanliness Verification:
   1. Visually inspect metal ducts for contaminants.
   2. Where contaminants are discovered, re-clean and reinspect ducts.

5.6 DUCT SCHEDULE

A. Fabricate all ducts with galvanized sheet steel unless otherwise as specified.

B. Intermediate Reinforcement:

1.	Galvanized-Steel Ducts:	Galvanized steel.

C. Ductwork material to be as follows:

1-	HVAC supply, return, fresh air, air intake	Pre-insulated Duct
2-	Exhaust and extract duct	Galvanized Steel
3-	Kitchen hood exhaust (Commercial)	Carbon Steel
4-	Dishwasher Exhaust Steel,	Stainless Steel
5-	Battery Charging Room Exhaust	Stainless Steel

END OF SECTION 15810

SECTION 15820

DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Backdraft and pressure relief Vent dampers (PRV).
2. Barometric relief dampers.
3. Manual volume dampers.
4. Fire dampers.
5. Smoke dampers (MSD).
6. Combination fire and smoke dampers.
7. Flange connectors.
8. Duct silencers.
9. Turning vanes.
10. Remote damper operators.
11. Duct-mounted access doors, panels and sections.
12. Flexible connectors.
13. Flexible ducts.
14. Duct accessory hardware.

1.3 REFERENCES

A. The ductwork accessories shall comply fully with the latest relevant British or American standards and codes.

B. The following standards are the most commonly used, however the contractor shall comply with all relevant standards whether listed or not
1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
2. NFPA 92A - Recommended Practice for Smoke-Control Systems.
3. NFPA 92B - Guide for Smoke Management Systems in Malls, Atria, and Large Areas
4. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
5. ASHRAE 70 – Method of Testing for Rating Air Flow Performance of Outlets and Inlets.
6. UL 33 - Heat Responsive Links for Fire-Protection Service.
7. UL 555 - Fire Dampers.
8. UL 555S - Leakage Rated Dampers for Use in Smoke Control Systems.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
   1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
      a. Special fittings.
      b. Manual volume damper installations.
      c. Control damper installations.
      d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
      e. Duct security bars.
      f. Wiring Diagrams: For power, signal, and control wiring.

C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

D. Source quality-control reports.

E. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Comply with applicable codes and requirements of local authorities having jurisdiction whichever is more stringent.

1.6 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

1.7 WARRANTY

A. Furnish five year manufacturer warranty for duct accessories.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G90 (Z275).
   2. Exposed-Surface Finish: Mill phosphatized.

C. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B 221 (ASTM B 221M), Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less;3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.2 BACKDRAFT AND PRESSURE RELIEF VENT DAMPERS (PRV)

A. Description: Gravity balanced, suitable for horizontal or vertical installation.

B. Frame: galvanized sheet steel with welded cornersand mounting flange.

C. Blades: Multiple single-piece blades, center-pivoted, sheet with sealed edges.

D. Blade Action: Parallel.

E. Blade Seals: Neoprene, mechanically locked.

F. Blade Axles: Galvanized steel.

G. Tie Bars and Brackets: Galvanized steel.

H. Return Spring: Adjustable tension.

I. Blades shall include field adjustable, zinc plated steel counter balance weights to allow that 0.01 inches wg.

2.3 BAROMETRIC RELIEF DAMPERS

A. Suitable for horizontal or vertical mounting.

B. Frame: galvanized sheet steel, with welded corners and mounting flange.

C. Blades:

1. Multiple aluminum sheet.
2. Maximum Width: 6 inches (150 mm).
3. Action: Parallel.
4. Balance: Gravity.
5. Eccentrically pivoted.

D. Blade Seals: Neoprene.

E. Blade Axles: Galvanized steel.

F. Tie Bars and Brackets:
1. Material: Galvanized steel.
2. Rattle free with 90-degree stop.

G. Return Spring: Adjustable tension.

H. Bearings: Bronze.

J. Accessories:
1. Flange on intake.
2. Adjustment device to permit setting for varying differential static pressures.

2.4 MANUAL VOLUME DAMPERS

A. Standard, Manual Volume Dampers: Factory fabricated with required hardware and accessories –Multiple or single blade parallel or opposed blade design as indicated, and suitable for horizontal or vertical applications.

1. Frames:
   a. Hat shaped.
   b. Galvanized steel channels.
   c. Mitered and welded corners.
   d. Flanges for attaching to walls and flangeless frames for installing in ducts.
2. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Galvanized, roll-formed steel.
3. Blade Axles: Galvanized steel.
4. Bearings:
   a. Oil-impregnated bronze.
   b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
5. Blade Seals: Neoprene.
6. Tie Bars and Brackets: Galvanized steel.
7. Accessories:
   a. Include locking device to hold single-blade dampers in a fixed position without vibration.
8. Splitter Dampers:
   a. Material: Same gage as duct to 600 mm size in both dimensions, and two gages heavier for sizes over 600 mm.
   b. Fabricate blades of single thickness sheet metal to streamline shape for low velocity systems and double thickness sheet metal

to streamline shape for high velocity air systems. Blades shall be secured with continuous hinge or rod.

c. Operator: Minimum 6 mm diameter rod in self aligning, universal joint action, flanged bushing with set screw.

d. Single Blade Dampers: Fabricate for duct sizes up to 150 mm in height.

9. Quadrants:

a. Furnish locking, indicating quadrant regulators on single and multi-blade dampers.

b. On insulated ducts mount quadrant regulators on standoff mounting brackets, bases, or adapters.

c. Quadrant shall be with lockable cadmium plated screws, nuts and washers.

d. The quadrant shall be clearly marked "open" and "shut".

e. Where rod lengths exceed 750 mm furnish regulator at both ends.

2.5 FIRE DAMPERS

A. Type: Static and dynamic; rated and labeled according to UL 555 by an NRTL.

B. Fire rating:

1. Dampers shall have a UL555 fire rating of 1 ½ hours when used for the protection of openings in walls, partitions, or floors with the resistance ratings of less than 3 hours.

2. Dampers shall have a UL555 fire rating of 3 hours when used for the protection of openings in walls, partitions, or floors having a fire resistance rating of less than 3 hours or more.

C. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, galvanized steel; with mitered and interlocking corners.

D. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.052 or 0.138 inch (1.3 or 3.5 mm) thick, as indicated, and of length to suit application.

E. Mounting Orientation: Vertical or horizontal as indicated.

F. Blades: Roll-formed, interlocking, galvanized sheet steel. In place of interlocking blades, use full-length, galvanized-steel blade connectors.

G. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

H. Heat-Responsive Device: Fusible link, replaceable, factory installed, 165 deg F (74 deg C) rated.

2.6 SMOKE DAMPERS (MSD)

A. General Requirements: Label according to UL 555S by an NRTL.

B. Smoke Detector: Integral, factory wired for single-point connection.

C. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, galvanized steel; with mitered and interlocking corners.

D. Blades: Roll-formed, horizontal, interlocking, galvanized sheet steel.

E. Rated pressure and velocity to exceed design airflow conditions.

F. Mounting Sleeve: Factory-installed, 0.052-inch- (1.3-mm-) thick, galvanized sheet steel; length to suit wall or floor applicationwith factory-furnished silicone calking.

G. Damper Motors: two-position action, external mounting.

J. Comply with NEMA1 designation

K. Accessories:
   1. Auxiliary switches for position indication.

L. Bearings: Stainless steel pressed into frame.

2.7 COMBINATION FIRE AND SMOKE DAMPERS

A. Type: Static and dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

B. Closing rating in ducts up to 4-inch wg (1-kPa) static pressure class and minimum 4000-fpm (20-m/s) velocity.

C. Fire rating:
   1. Dampers shall have a UL555 fire rating of 1 ½ hours when used for the protection of openings in walls, partitions, or floors with the resistance ratings of less than 3 hours.
   2. Dampers shall have a UL555 fire rating of 3 hours when used for the protection of openings in walls, partitions, or floors having a fire resistance rating of less than 3 hours or more.

D. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, galvanized steel; with mitered and interlocking corners.

E. Heat-Responsive Device: Electric resettable link and switch package, factory installed, replaceable, 74 deg C rated.

F. Smoke Detector: Integral, factory wired for single-point connection.

G. Blades: Roll-formed, horizontal, interlocking, galvanized sheet steel. In place of interlocking blades, use full-length, galvanized-steel blade connectors.

H. Leakage: Class I, low leakage at 120 deg C.

J. Rated pressure and velocity to exceed design airflow conditions.

K. Mounting Sleeve: Factory-installed, 0.052-inch- (1.3-mm-) thick, galvanized sheet steel; length to suit wall or floor application.

L. Actuator: Electric, two position, 120 volt, 50 hertz.

M. Damper Motors: two-position action, external mount.

N. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 15 Section "Common Motor Requirements for HVAC Equipment."

P. Accessories:
   1. Auxiliary switches for position indication.

Q. Bearings: Stainless steel pressed into frame.

2.8 FLANGE CONNECTORS

A. Description: roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

B. Material: Galvanized steel.

C. Gage and Shape: Match connecting ductwork.

2.9 DUCT SILENCERS

A. General Requirements:
   1. Factory fabricated and tested, round or rectangular silencer with performance characteristics and physical requirements as indicated.
   2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.
   3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

B. Rectangular Silencer Outer Casing: galvanized sheet steel.

C. Round Silencer Outer Casing: galvanized sheet steel.

D. Inner Casing and Baffles: galvanized sheet metal, and with 1/8-inch- (3-mm-) diameter perforations.

E. Connection Sizes: Match connecting ductwork unless otherwise indicated.

F. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.

H. Acoustic Fill Material: Inert, moister-proof, vermin-proof material.

2.10 TURNING VANES

A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

B. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."

C. Vane Construction: Double wall.

2.11 REMOTE DAMPER OPERATORS

A. Description: Cable system designed for remote manual damper adjustment.

B. Tubing: Brass.

C. Cable: Stainless steel.

D. Wall-Box Mounting: Surface.

E. Wall-Box Cover-Plate Material: Stainless steel.

2.12 DUCT MOUNTED ACCESS DOORS, PANELS AND SECTIONS

A. Provide access doors, sized and located for maintenance work, upstream, in the following locations:
   1. Each duct mounted coil and humidifier.
   2. Each fire damper (for link service), smoke damper and automatic control damper.
   3. Each duct mounted smoke detector.
   4. For cleaning operating room supply air duct and kitchen hood exhaust duct, locate access doors at 6 m (20 feet) intervals and at each change in duct direction.

B. Openings shall be as large as feasible in small ducts, 300 mm by 300 mm (12 inch by 12 inch) minimum where possible. Access sections in insulated ducts shall be double-wall, insulated. Transparent shatterproof covers are preferred for uninsulated ducts.
   1. For rectangular ducts: Refer to SMACNA Standards.
   2. For round and flat oval duct: Access sections shall be not less than 1.0 mm (20 gage) housing welded or riveted to a duct section.

2.13 FLEXIBLE CONNECTORS

A. Materials: Flame-retardant or noncombustible fabrics.

B. Coatings and Adhesives: Comply with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches (89 mm) wide attached to 2 strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
   1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
   2. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
   1. Minimum Weight: 24 oz./sq. yd. (810 g/sq. m).
   2. Service Temperature: Minus 50 to plus 250 deg F (Minus 45 to plus 121 deg C).

F. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
   1. Minimum Weight: 16 oz./sq. yd. (542 g/sq. m).
   2. Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C).

2.14 FLEXIBLE DUCTS

A. General: Comply with UL 181, Class 1.

B. Flexible Ducts, Uninsulated: Spiral-wound steel spring with flameproof vinyl sheating.

C. Flexible Ducts, Insulated: Factory-fabricated, insulated, round duct, with an outer jacket enclosing 1-1/2-inch-(38mm-) thick, glass-fiber insulation around a continuous inner liner.
   1. Reinforcement: Steel-wire helix encapsulated in inner liner.
   2. Outer Jacket: Glass-reinforced, silver Mylar with a continuous hanging tab, integral fibrous-glass tape, and nylon hanging cord.
   3. Inner liner: Polyethylene film.

D. Pressure rating: 6 inch wg (1500 Pa) positive, ½-inch wg (125 Pa) negative.

2.15 DUCT ACCESSORY HARDWARE

E. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

F. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

G. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 75 to 450mm to suit duct size.

H. Splitter Damper Accessories: Zinc-plated damper blade bracket, 6-mm, zinc-plated operating rod; and a duct-mounted, ball-joint bracket with flat rubber gasket and square-head set screw.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fireand smoke dampers according to UL listing, NFPA, safety regulations and as shown on the drawings.

H. Connect ducts to duct silencers with flexible duct connectors.

J. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On both sides of duct coils.
   2. Upstreamand downstream from duct filters.
   3. At drain pans and seals.
   4. Downstream from manual volume dampers, fire dampers, control dampers, backdraft dampers, and equipment.
   5. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
   6. Upstreamand downstream from turning vanes.
   7. Control devices requiring inspection.
   8. Elsewhere as indicated on drawings and details.

K. Install access doors with swing against duct static pressure.

L. Label access doors according to Division 15 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

M. Install flexible connectors to connect ducts to equipment.

P. Install duct test holes where required for testing and balancing purposes.

Q. Install fire dampers at all fire compartments to maintain integrity of fire rating.

R. Install duct silencer / sound attenuators wherever required by calculations showing that sound level exceeds the applicable code (ASHRAE requirements).

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Operate dampers to verify full range of movement.
   2. Inspect locations of access doors and verify that purpose of access door can be performed.
   3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
   4. Inspect turning vanes for proper and secure installation.
   5. Operate remote damper operators to verify full range of movement of operator and damper.

3.3 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Adjust fire and smoke dampers for proper action.

C. Final positioning of manual-volume dampers is specified in Division 15 Section "Testing, Adjusting, and Balancing".

3.4 DEMONSTRATION

A. Demonstrate re-setting of fire dampers and smoke dampers to the engineer and owner’s representatives.

END OF SECTION 15820

SECTION 15837
FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. In-Line Centrifugal Fans.
   2. Twin Centrifugal Fans.
   3. Low Noise Mixed Flow Fans (Silent Fans).
   4. Roof Fans.
   5. Kitchen Exhaust Fans.
   6. Axial Fans.
   7. Smoke Extraction Fans.
   8. Jet Fans.
   9. Decorative Propeller Fans
   10. Bathroom decorative wall / Ceiling Propeller fan.
   11. Humidifier
   12. Air Purifire.
   13. Air Curtains

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan performance ratings on actual project site elevation above sea level.

B. Air performance for axial fans shall be according to ISO 5801 or equivalent.

C. Fire Rating: Where indicated on schedules of equipment,fans to be firerated 300°C/2hr.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
   1. Fan performance curves with system operating conditions indicated.
   2. Fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Dampers, including housings, linkages, and operators.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support

locations, type of support, and weight on each support. Indicate and certify field measurements.

D. Operation and Maintenance Data: For fans to include in emergency, operation, and maintenance manuals.

E. Selection data for each fan for approval before ordering.

F. Furnish and install as indicated on the drawings and plans, an in space centrifugal humidification system complete and ready to operate.

G. Furnish owner's manuals and blueprints covering installation, start up, maintenance and operating instructions, complete in every way to permit efficient operation and maintenance of the system.

H. Manufacturer's Data: submit manufacturer's product data including dimensions, sizes, weights, installation, instructions, storage, instructions, and code compliance reports.

1.5 QUALITY ASSURANCE

A. Material and equipment shall conform to the latest edition of applicable codes, European Norms and requirements of local authorities having jurisdiction.

B. Manufacturers: Firms regularly engaged in manufacture of all Fans types, sizes and capacities required, whose products have been in satisfactory use in similar service for not less than 10 years.

C. The Agent or Authorized Dealer should be representing directly the manufacturer, a formal letter should be issued in the name of the Agent or Authorized Dealer directly from the manufacturer.

D. The Agent or Authorized Dealer should be registered in Jordan for not less than 5years, and should have experience in selling, installing and maintaining Fans systems in Jordan.

Guarantee: Fans shall be the latest and newest model and latest technology for the manufacturer products and shall include a (2) two years full guarantee, full warranty and full preventive maintenance on all parts and labor after acceptance by the Engineer and the owner including regular visits two times a year and upon request (cost of spare parts ,labor and regular visits and upon request deemed to be included in the contractor's cost for the two years after acceptance) .

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.

B. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.8 EXTRA MATERIALS

A. Furnish two sets of belts for each belt-driven unitthat match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.9 WARRANTY

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

B. Special Warranty: A written warranty, signed by Contractor and manufacturer, agreeing to replace any axial fan or component that do not meet requirements or that fail within the specified warranty period.

1. Warranty period: 2 years from date of Substantial Completion for any component of the fans.

PART 2 - PRODUCTS

2.1 GENERAL FAN REQUIREMENTS

A. General
1. Performance data for all fans and spare parts shall be determined in accordance with the provisions of ISO 5801 and AMCA 210 or equivalent.
2. Sound pressure level ratings of ducted fans shall comply with ISO3744or equivalent.
3. Sound pressure level ratings of non-ducted fans shall comply with ISO 3744 or equivalent.
4. Safety provisions for power transmission equipment and non-ducted inlets and outlets shall include guards and screens, unless other provisions are required, and shall be constructed in accordance with applicable provisions of ASME; Installation shall be such that fan vibration-isolation provisions are not negated.
5. Fan wheels shall be statically and dynamically balanced at the factory according to ISO 1940-1 grade G6.3.

B. Corrosion Protection: All steel shall be mill-galvanized, or phosphatized and coated with minimum two coats, corrosion resistant enamel paint.

2.2 INLINE CENRIFUGAL FANS

A. Description: fully factory fabricated-assembled-tested and finished belt or direct drive with galvanized steel housing lined with acoustic insulation, removable side panel for access, inlet and outlet duct collar, gravity back draft damper in discharge, horizontal hanging brackets.

B. Wheel: backward or forward inclined centrifugal type statically and dynamically balanced.

C. Motor and Drive Mounting: Within air stream.

D. Motor: totally enclosed air over motor IEC rating, class F insulation and IP55 protection mounted on vibration isolators.

E. Direct-drive Units: Motor encased in housing, factory or field wired to disconnect located on outside of fan housing.

F. Bearings: shall be air handling quality, heavy duty, pillow block type. Bearings shall be selected for a basic rating life L10 of 100,000 hours.

G. Performance: Refer to schedules on the drawings

H. Electrical Characteristics and Components:
   1. Electrical Characteristics: In accordance with related sections in Division 16.
   2. Refer to Electrical drawings and schedules for related electrical data.

2.3 TWIN FANS

A. Configuration: fully fabricated-assembled- tested- finished and lined box fitted with two forward facing centrifugal fans for independent working, each unit fitted with factory mounted back draft damper complete with auto-change over electrical panel, the electrical panel should suitable for outdoor mounting and dust proof with IP56 and suitable for BMS interface.

B. Centrifugal Fan Unit: Direct driven with galvanized steel housing lined with acoustic insulation, resilient mounted motor, integral inlet and outlet duct collar

C. Wheel: Centrifugal forward curved type constructed of galvanized steel.

D. Motor: totally enclosed air over motor IEC rating, class F insulation with external rotor, incorporated thermal protector, ball bearings and IP54 protection.

E. Working temperature -20 to +60 °C.

F. Mounting brackets on the base make installation easier.

G. Performance: Refer to schedules on the drawings.

2.4 SILENT FANS.

A. Description: direct-drive mixed flow fans, as indicated, consisting of housing, wheel, fan shaft, motor with durable ball bearing, and hangers.

B. Housings: Heavy Galvanized steel sheet with anticorrosive polymer coating.

C. Fan wheel: GI, FRP, plastic wheel with mixed flow blades.

D. Acoustical: Thermal and acoustic insulation with ROCKWOOL; and Internal perforated casing to facilitate noise absorption.

E. Operating temperature: -10ºC +60ºC.

2.5 ROOF FANS.

A. Description: Belt-driven or direct-drive centrifugal fans, as indicated, consisting of housing, wheel, fan shaft, bearings to be an average life of 100,000 hours, motor and field mount disconnect switch, drive assembly, curb base and accessories.

B. Housings: Removable, sheet steel rain deflector hood with anticorrosive protection, with sheet steel base plate; square, one piece, base with venture inlet cone, discharge baffle to direct discharge air downward and protection guard.

C. Fan wheels: galvanized steel wheel with backward inclined blades, airfoil or axial blade.

D. Belt Driven Drive Assembly: Resiliently mounted to the housing, with the following features:
   i. Fan shaft: Turned, ground, and polished steel drive shaft keyed to wheel hub.
   ii. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings of average life shall not be less than 100,000 hours.
   iii. Pulleys: Cast iron, adjustable-pitch motor pulley.

E. Motor: totally enclosed air over motor IEC rating, class F insulation IP54 protection, fully coved by fan housing.

2.6 KITCHEN EXHAUST FANS

A. Application: Roof mounted fan especially designed for removal smoke and grease laden working at continuous air stream temperature +120°C and fire rated 400°C/2hr according to EN 1210.

B. Description: Belt-driven or direct-drive centrifugal fans, as indicated, consisting of housing, wheel, fan shaft, bearings to be an average life of 200,000 hours, motor and field mount disconnect switch, drive assembly, protection guard, curb base and accessories

C. Housings: Removable, aluminum rain deflector hood, with galvanized sheet steel base plate; square, one piece, base with venture inlet cone.

D. Fan wheels: galvanized steel wheel with backward inclined blades.

E. Belt Driven Drive Assembly:
   1. Resiliently mounted to the housing, with the following features:
   2. Fan shaft: Turned, ground, and polished steel drive shaft keyed to wheel hub.
   3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings of average life shall not be less than 200,000 hours.
   4. Pulleys: Cast iron, adjustable-pitch motor pulley.

F. Motor: totally enclosed air over motor IEC rating, class F insulation IP55 protection, fully coved by fan housing and totally isolated form exhaust air stream.

2.7AXIAL FANS

A. Description: direct-drive axial fans as indicated, consisting of fan blades, hub, housing, motor, and accessories.

B. Casing: fan casing shall be heavy gauge, sheet steel, roll formed, welded and hot dipped galvanized after fabrication to BS EN ISO1461:2009 with flanged edges and with baked-enamel anticorrosive finish coat or equivalent and shall be cover all fan's components.

C. Fan Impeller: adjustable pitch airfoil section impeller with cast aluminum blades

D. Fan Hub: high quality cast aluminum.

E. Incorporate integral mounting flanges with industry standard drillings, to allow the rear of the platform mounted motor to partially protrude beyond the flange.

F. Motor: totally enclosed air over motor or fan cooled IEC rating, class F insulation IP55 protection, working temperature -20 to +50 °C, motor shall be wired weather proof cable to IP55 protected terminal box mounted on the outside of the fan casing.

G. Accessories: The following accessories are required as indicated:
   1. Gravity Shutters: Aluminum gravity damper.
   2. Mounting Brackets.
   3. Vibration Isolators.
   4. Protection guard.

2.8 SMOKE AXIAL EXTRACTION FANS.

A. Description: direct-drive fire rated 300°C/2hr axial fan according to EN 1210, and approved by Civil Defense, consisting of fan blades, hub, housing, motor, and accessories.

B. Casing: fan casing shall be heavy gauge, sheet steel, roll formed, welded and hot dipped galvanized after fabrication to BS EN ISO1461:2009 with flanged edges and with baked-enamel anticorrosive finish coat or equivalent and shall be cover all fan's components.

C. Fan Impeller: adjustable pitch airfoil section impeller with cast aluminum blades

D. Fan Hub: high quality cast aluminum

E. Incorporate integral mounting flanges with industry standard drillings, to allow the rear of the platform mounted motor to partially protrude beyond the flange.

F. Motor: totally enclosed air over motor (TEAO), class H insulation IP55 protection, working temperature -20 to +50 °C, motor shall be wired fire resistance cable to IP55 protected terminal box mounted on the outside of the fan casing.

2.9 JET FANS

A. Description: single direction, 2 speed impulsion fan with two silencer, deflector, and brackets, certified for smoke extraction according to EN 12101 300 °C/2hrs

B. Casing: Heavy gauge sheet steel, roll formed, hot dipped galvanized after fabrication, with integral 4 points mounting feet allow unit to be mounted easily.

C. Fan Impeller: cast aluminum designed for optimum thrust as indicated, hub made of pressure die cast aluminum.

D. Silencer: integral inlet and outlet silencer mounted in the either side of the fan housing, with an integral bell mouth to reduce sound level and optimal performance. Silencer shall be constructed of outer galvanized steel sheet and per-galvanized perforated sheet inner lining, Inlet silencer fitted with zinc plated guard and the outlet silencer fitted with deflector to guide the air in the requested direction.

E. Motor: totally enclosed air over motor class H insulation, with ball bearing and IP55 protection.

2.10 DECORATIVE PROPELLER FANS

A. Decorative fans for wall-mount, ceiling mount and window mount applications.

B. High performance impeller and durable ABS plastic housing decorative type, low noise design.

C. High performance impeller and long life bearing for an average life time of 60,000 hours.

D. Fans equipped with louver and durable automaticor gravity shutter.

2.11 BATHROOM DECORATIVE WALL/CEILING PROPELLER FAN

A. The bathroom propellers should be 50 cycle, 230 Volt unit for wall/ceiling mounting with a high performance axial impeller and durable ABS white plastic housing decorative type. The Motor ambient temperature should be at least 40 degrees C.

B. Fan should be equipped with automatic shutter.

C. Fan sound level should not exceed 38-42 dB(A) at 3m.

2.12 Humidifier

A. Humidifier shall be optimum humidity distribution.

B. Humidifier shall have Electronic water level detector.

C. Humidifier shall have Electronic overflow detector.

D. Humidifier shall have Silver ionizing

E. Humidifier shall have Filter set for air cleaning

F. Humidifier shall have Water connection

G. Humidifier shall have Control via radio hygrostat

H. Brackets for installation on walls/floors.

I. Unit shall have water reservoir which includes float valve to automatically regulate water level.

J. Humidifier shall include motor, impeller, disk and breaker comb to produce a fine vapor.

K. Rotating parts shall be electronically balanced to eliminate vibration.

2.13 Air Purifire.

A. Air Purifire shall have Powerful air purification to increase indoor air quality, using Streamer technology

B. Air Purifire shall have a quiet operation.

C. Air Purifire shall have Easy to clean flat panel.

2.14 INSTALLATION

A. Install fans level and plumb and according to manufacturer's recommendation

B. Support suspended units from structure using threaded steel rods andspring hangers with vertical-limit stops having a static deflection of 1 inch (25 mm).

C. Install units with clearances for service and maintenance.

D. Label fans according to requirements specified in Division 15 Section "Mechanical Identification."

2.15 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of ducts and

duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 15 Section "Duct Accessories."

2.16 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.
   4. Adjust belt tension.
   5. Adjust damper linkages for proper damper operation.
   6. Verify lubrication for bearings and other moving parts.
   7. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
   8. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

2.17 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

2.18 CLEANING

A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.

2.19 DEMONSTRATION

A. Engage a factory – authorized service representative to train Owner’s maintenance personnel to adjust, operate and maintain fans and controllers.

2.20 Air Curtains

Electric air curtains, operating at two different speeds (TWO OPERATING SPEED), so that they are of a length not less than the width of the doors, and the outer surface of them is aluminum and not painted iron, and the price includes the electrical installation, and that it is from a well-known.

END OF SECTION 15837

SECTION 15850

AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Diffusers.
   2. Registers
   3. Grilles.
   4. Door grilles.
   5. Louvers.
   6. Louvered Benthouse.
   7. Goosenecks.
   8. Air Curtains
   9. Jet diffuser

1.2 SUBMITTALS

A. Product Data: Submit sizes, finish, and type of mounting. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

B. Samples: Submit two of each required air outlet and inlet type.

C. Test Reports: Rating of air outlet and inlet performance.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.3 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of air outlets and inlets.

1.4 QUALITY ASSURANCE

A. Test and rate diffuser, register, and grille performance in accordance with ASHRAE 70.

B. Test and rate louver performance in accordance with AMCA 500.

C. Perform work in accordance with local standered.

D. Maintain one copy of each document on site.

1.5 MOCK-UP

A. Construct typical interior ceiling module with supply and return air outlets.

B. Locate where directed by Architect/Engineer.

C. Incorporate accepted mock-up as part of Work.

PART 2 PRODUCTS

2.1 ROUND CEILING DIFFUSERS

A. Product Description: Type: Round adjustable pattern, spun, multi-core diffuser to discharge air in 360 degree pattern, with sector baffles where indicated. Diffuser collar not more than 25 mm above ceiling. In plaster ceilings, furnish plaster ring and ceiling plaque.

B. Fabrication: Aluminum with baked powder enamel off-white finish ,and final color as directed by engineer/ID.

C. Accessories: opposed-bladebutterfly combination splitter damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.2 RECTANGULAR, SQUARE AND ROUND CEILING DIFFUSERS

A. Type: Square or rectangular adjustable pattern, stamped, multi-core, multi-louvered diffuser to discharge air in four way pattern. Otherwise one way, two-way or three-way when indicated on drawings.

B. Frame: Snap-in type.T-bar Splinetype,In plaster ceilings, furnish plaster frame and ceiling frame.

C. Fabrication: Aluminum with baked powder enamel off-white and final color as directed by engineer/ID.

D. Accessories: opposed-blade butterfly combination splitter damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.3 CEILING SLOT DIFFUSERS

A. Type: Continuous 20 mm wide or as indicated on drawing, with number of slots as required to achieve throw and noise level or as shown on drawing, with adjustable vanes for left, right or vertical discharge, integral ceiling fire damper.

B. Fabrication: Aluminum extrusions with factory clear lacquer baked powder enamel smooth finish, and final color as directed by engineer/ID.

C. Frame: 32 mm margin with countersunk screw concealed support clips for suspension system mounting and gasket end cap.

D. Plenum: Integral, galvanized steel, insulated and with spigots for round flexible duct connection or direct duct connection.

E. Provide volume control damper: opposed blade.

2.4 WALL SUPPLY REGISTERS/GRILLES

A. Type: Streamlined and individually adjustable blades, 19 mm minimum depth, 19 mm maximum spacing with spring or other device to set blades, double deflection with front vertical bars and rear horizontal bars.

B. Frame: 32 mm margin with concealed mounting and gasket.

C. Fabrication: Aluminum extrusions, with factory baked enamel smooth finish, color to be selected by the Engineer.

D. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.

2.5 WALL AND CEILING RETURN AND EXHAUST REGISTERS/GRILLES

A. Type: Fixed horizontal blades at 19mm centers and set at 45°.

B. Frame: 32 mm margin with concealed mounting and gasket.

C. Fabrication: Aluminum extrusions, with factory baked enamel smooth finish, color to be selected by the Engineer.

D. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.

2.6 BAR GRILLES

A. Type: Linear bar grilles, single deflection, with supply angle as required to achieve throw and noise level.

B. Fabrication: Aluminum extrusions with factory baked powder enamel smooth finish, color to be selected by the Engineer.

C. Frame: 32 mm margin with concealed support clips for suspension system mounting and gasket end cap.

D. Plenum: Integral, galvanized steel, with acoustic lining and spigots for round flexible duct connection or direct duct connection.

E. Provide opposed blade volume control damper.

2.7 DOOR LOUVERS

A. Type: V-shaped fixed type louvers of 0.90 mm thick aluminum, 25 mm deep on 13 mm centers, to be supplied with fire damper where required.

B. Frame: 0.90 mm aluminum with auxiliary frame to give finished appearance on both sides of door, with backed powder enamel. Colour to be selected by the Engineer.

C. Shall be installed with bottom at a uniform height of 40 cm above floor level or as directed by engineer.

2.8 LOUVERS

A. Product Description: Stationary Drainable.

B. Type: 100 mm deep with blades on 45 degree slope with center baffle and return bend, heavy channel frame.

C. Fabrication: 2.50 mm thick extruded aluminum, welded assembly, with factory baked enamel anodized finish color to be selected by the Engineer.

D. Mounting: Furnish with exterior angle flange screw holes in jambs for installation.

E. Bird Screen: Bird screen with 13 mm square mesh for exhaust and 19 mm for intake.

F. Insect Screen: Aluminum mesh, set in aluminum frame.

G. Color and paint as directed by engineer and ID.

2.9 LOUVERED BENTHOUSE :

A. Louvers: Type as specified and indicated on drawings.

B. Fabrication: Completely welded assembly. Fabricate with mitered corners. Structural supports rated for 0.96 kPa wind and snow loading. Furnish sill water catch with 50 mm high water stop and depth to enclose structural supports.

C. Roof: Aluminium construction, standing seam type with formed water baffle plates open at corners for drainage. Furnish with 25 mm glass fiber insulation.

D. Bird Screen: Interwoven, wire mesh of steel, 1.6 mm diameter wire, 13 mm open weave, square design.

E. Insect Screen: aluminum mesh set in aluminum frame.

F. Finish: Factory anodized finish. Color of finish should be approved by the architects / interior designer before installing.

G. Louvers shall be weather proof.

2.10 GOOSENECKS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, of minimum 1.20 mm galvanized steel.

B. Roof Curb: 300 mm high self-flashing aluminum construction with continuously welded seams and factory installed nailer strip.

2.11 AIRCURTAINS

Concealed type, Horizontal mounted at topof the entrance door ,with

minimum velocity of 2.5 m/s at floor level with minimum of 2 speed and low noise not larger than 53dB(A), with Recommended installation height not less than 3m .
Bottom plate shall be made of white lacquered aluminum
Nin visible parts shall be made of hot Zinc plated steel panels.
Fixation : suspended
Control : Air curtains shall be automatically controlled and shall be switched ON if door is open and shall be switched OFF, after door closed.
Control shall be thru door contact, motion detector or any other approved method to comply with the above requirements.

2.12 JET DIFFUSERS

A. Type: round adjustable pattern, stamped, multi-core, multi-louvered diffuser to discharge air in jet pattern..

B. Frame: Snap-in type.T-bar Splinetype, In plaster ceilings, furnish plaster frame and ceiling frame.

C. Fabrication: Aluminum with baked powder enamel off-white and final color as directed by engineer/ID.

D. Accessories: opposed-blade butterfly combination splitter damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify inlet and outlet locations.

B. Verify ceiling wall systems are ready for installation.

3.2 INSTALLATION

A. Install diffusers to ductwork with airtight connection.

B. Install balancing dampers on duct take-off to diffusers, grilles, and registers, whether or not dampers are furnished as part of diffuser, grille, and register assembly.

C. Paint visible portion of ductwork behind air outlets and inlets matte black.

3.3 INTERFACE WITH OTHER PRODUCTS

A. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

END OF SECTION 15850

PLUMBING AND FIRE FIGHTING SPECIFICATIONS

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SECTION 10800

TOILET ACCESSORIES

PART 1: GENERAL

1.01 SCOPE OF WORK

A Furnish all labor, materials, equipment and incidentals required and deliver all toilet and shower accessories and as specified herein.

1.02 RELATED WORK

A Installation is included in Division 15.

1.03 SUBMITTALS

A Submit to the Engineer, complete shop drawings, manufacturer's catalog cuts and data sheets, complete parts list including gauge and type of material and all fasteners, installation requirements and construction details.

B Submit to the Engineer for approval, one representative sample of each item and model specified, if requested.

C Submit certificate of verification by an independent testing organization of grab bar strength and installation.

D Furnish at the time of delivery of materials, four complete sets of maintenance instructions.

1.04 DELIVERY, STORAGE AND HANDLING

A Deliver materials in manufacturer's original unopened and undamaged packages with labels legible and intact. Store materials in unopened packages in a manner to prevent damage from the environment and construction operations. Handle in accordance with manufacturer's instructions.

PART 2: PRODUCTS

2.01 MATERIALS

Products specified inthis itemare products as manufactured by Bobrick Washroom Equipment, Inc. and are used only to determine quality, appearance, workmanship, gauge of metal, capacity and finish. Equal products by the approved list of manufacturers, will be acceptable, if, in the opinion of the Engineer, they meet the intent of this specification

as stated immediately above. Accessories furnished shall be the products of one manufacturer. Provide items complete with all screws, bolts and anchoring devices required for installation.

Surface-mounted hat and coat hook
Surface-mounted hat and coat hook shall be constructed of type-304 stainless steel with satinfinish and shall project 3-1/16" (80mm) from wall. Flange and support arm shall be 22-gauge (0.8mm) and equipped with a concealed, 16-gauge (1.6mm) mounting bracket that is secured to a concealed, 16-gauge (1.6mm) wall plate with a stainless steel setscrew. Hook shall be 12-gauge (2.8mm) and shall be welded to support arm.
Similar to Bobrick Model B-6827 or approved equal on quality and appearance, from the proposed manufacturer list only.

Surface-mounted automatic hand dryer
Surface-mounted hand dryer shall have a one-piece cast iron cover with white color vitreous enamel finish. Nozzle shall adjust for hand and face drying. Nozzle shall automatically return to hand drying position; and cannot be used as a vessel to hold liquids. International operating symbols shall be permanently fused into vitreous enamel cover. Motor shall be 1/10 hp, 6200 rpm, with automatic thermal overload switch. Centrifugal fan shall direct air flow through heating element at 150 cfm. Heating element shall be rated at 2300 watts, shall be located on inlet side of fan, shall heat air without hot spots, and be inaccessible to vandals. Electronic sensor shall automatically turn dryer on when hands or self-returning nozzle are held under the air-outlet opening and will shut off automatically when hands are removed or self-returning nozzle is released. Sensor shall shut off automatically after 90 seconds if an inanimate object is used to activate dryer and resets itself after inanimate object is removed. Unit shall be UL Listed, and or VDE approved, CE marked. Unit shall comply with EU Directive “Restriction of Hazardous Substance” (ROHS) requirements for non-use of certain hazardous substances in the production of electronic products. Unit shall be protected by a limited 10-year warranty on all parts except motor brushes. Motor brushes shall be warranted for a period of three years from date of purchase.
Similar to Bobrick Model B-700 (white), or approved equal on quality and appearance, from the proposed manufacturer list only.

Surface-mounted vertical soap dispenser
Surface-mounted soap dispenser shall be constructed of type-304 stainless steel with satin finish. Corrosion-resistant valve shall dispense commercially marketed all-purpose hand soaps. Valve shall be operable with one hand and with less than 5 pounds of force (22.2 N). Container shall be equipped with a, clear acrylic refill-indicator window; a locked, hinged stainless steel lid for top filling; and shall have a capacity of 40-fl oz (1.2-L). Unit shall have concealed, vandal-resistant mounting.
Similar to Bobrick Series Model B-2111 ,or approved equal on quality and appearance, from the proposed manufacturer list only.

Stainless steel grab bar
Stainless steel grab bar, 1-1/4" (32mm) diameter, with snap flange cover. Grab bar and concealed mounting plates shall be constructed of type-304 stainless steel with satin finish. Grab bar shall have wall thickness of 18-gauge (1.2mm) and outside diameter of 1-1/4" (32mm). Distance from inside of grab bar to finished wall shall be 1-1/2" (38mm). Flanges shall be 1/ 8" (3mm) thick stainless steel plate, 2" x 3-1/8" (79mm) in diameter, and each shall have two

screws holes. Flange covers shall be 22-gauge (0.8mm) and shall snap over mounting flanges to conceal mounting screws. Grab bar shall have 90º return to flange. Ends of grab bar shall pass through flanges and be heliarc welded to form one structural unit.
Similar to Bobrick Series B-5806x24 (600mm length) ,or approved equal on quality and appearance, from the proposed manufacturer list only.

Stainless steel swing-up grab bar
Stainless steel swing-up grab bar shall be constructed of type-304 stainless steel with satin finish (or satin finish with peened gripping surface; add .99 suffix to model number). Grab bar shall have wall thickness of 18-gauge (1.2mm) and outside diameter of 1-1/4" (32mm). Backplate shall be constructed of type-304 3/16" (5mm) thick stainless steel with satin finish with 4 countersunk holes for attachment to the wall. Swing-up grab bar shall be manually raised for approach or departure and lowered to horizontal position for support. Once bar is raised more than 45° from horizontal position, counterweighted design shall prevent bar from falling. Grab bar shall comply with ICC/ANSI A117.1-2003 Accessibility Standards in U. S. A.
Similar to Bobrick Model B-4998,or approved equal on quality and appearance, from the proposed manufacturer list only.

Single-roll toilet tissue dispenser
Single-roll toilet tissue dispenser shall be type-304 stainless steel with satin finish. Unit shall accommodate one standard-core toilet paper roll up to 5-1/2" (140mm) diameter (1800 sheets). Flanges and support arms shall be 22- gauge (0.8mm) and equipped with concealed, 16-gauge (1.6mm) mounting brackets that are secured to concealed, 16-gauge (1.6mm) wall plates with stainless steel setscrews. *Spindle shall be chrome-plated plastic with a heavy-duty internal spring. Manufacturer's service and parts manual shall be provided to the building owner/manager upon request.*To specify theft-resistant spindle as an optional accessory, add to specification: Theft-resistant spindle shall be removable only with special key provided.Single-Roll Toilet Tissue Dispenser shall be similar to BobrickModel B-6857or approved equal on quality and appearance, from the proposed manufacturer list only.

Surface-mounted waste receptacle.
surface-mounted fabricated of type-304 stainless steel with all-welded construction.Exposed surfaces shall have satin finishFront and sides of waste receptacle shall be one-piece, 22 gauge (0.8mm); back and bottom shall be one-piece, 26gauge (0.5mm).Top edge shall be hemmed and bottom of waste receptacle shall have recessed finger grip. Waste receptacle shall be equipped with four interior hooks, furnished with a removable heavy-gauge vinyl line. W355mm x H455mm. Minimum capacity: (24-L).Similar to Bobrick Model B-279,or approved equal on quality and appearance, from the proposed manufacturer list only.

Stainless steel channel frame mirror,
Mirror shall have a one-piece, type-430 stainless steel channel-frame, 1/2" x 1/2" x 3/8" (13 x 13 x 9.5mm), with 90º mitered corners; all exposed surfaces shall have bright polished finish. Mirror shall be No. 1 quality, 1/4" (6mm) float glass. Corners shall be protected by friction-absorbing filler strips and the back shall be protected by full-size, shock absorbing, water-resistant, nonabrasive, 3/16" (5mm) thick polyethylene padding. Galvanized steel back shall have integral horizontal hanging brackets located at top and bottom for mounting on concealed

rectangular wall hanger to prevent the mirror from pulling away from the wall. Locking devices secure mirror to concealed wall hanger. Mirror shall be removable from the wall.
Similar to Bobrick Series B-165**.** or approved equal on quality and appearance, from the proposed manufacturer list only.

PART 3: EXECUTION

3.01 INSTALLATION

A Installation is included in Division 15 but shall be performed as specified below.

B Coordinate rough opening size and location of masonry recesses with masonry work. Provide mason with rough opening dimensions.

C Use concealed fastenings where so designed.

D Attach accessories securely to walls and partitions in locations as shown or directed.

E Mounting height for accessories used shall conform to the applicable code.

F Where required, install concealed mounting devices and fasteners fabricated of the same material as the accessories, or of galvanized steel, as recommended by manufacturer.

G Elsewhere, install exposed mounting devices and fasteners finished to match the accessories.

H Provide theft-resistant fasteners for all accessory mountings.

I Secure toilet and shower accessories in accordance with the manufacturer's instructions for each item and each type of substrate construction.

END OF SECTION 010800

SECTION:15020

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32	Installation of Piped Services
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STANDARDS

1 INTRODUCTION

This General Specification indicates the minimum standard of Work, workmanship and materials necessary for the execution of the Contract to the approval of the Engineer and the true intent of this Specification and associated Drawings.

2 DESIGN STANDARDS

The installation shall conform to:

a) The general and specific requirements of the local water authority, public health officer, local drainage inspectorate and other local statutory authorities.

b) Local authority by laws and other regulations.

c) General and specific requirements of the local fire officer.

d) Relevant codes of practice of the British Standards Institution.

e) The requirements of the insurance companies concerned.

f) National Fire Protection Agency (NFPA)

g) American Society for Heating. Refrigeration, and air Conditioning specifications (ASHRAE).

h) The regulations for the electrical equipment of buildings, (current edition) published by the Institution of Electrical Engineers. London.

j) The recommendations of the manufacturers of all materials, plant and equipment.

i) Department of health and social security (U.K.), (D.H.S.S.) health building system engineering nucleus, Volumes 3 and 4C.

m) National Plumbing Code.

n) Hotel Operator-Architectural & Engineering Standards.

(Awarded contractor is to cross examine full compliance of all Technical Standards with IHC engineering standards. Contractor shall coordinate with site engineer for any deviations before erections).

3 SAFETY AND FIRE PRECAUTIONS

The Contractor shall ensure that safe methods of working are followed when using any equipment of materials which may involve a danger to life or to property and he is to take all necessary precautions to safeguard against damage by fire or explosion where the execution of the works may involve the presence of flame or sparks.

4 CONTRACTOR'S PLANT AND TOOLS

The Contractor, unless otherwise specified, shall provide all materials, tackles, slings, scaffolding, ladders, haulage, labor and apparatus necessary for the supply, delivery and erection of the plant on site.

The Contractor shall be responsible for providing at his own expense, all the requirements such as hand tools, hand lamps, and transformers, where necessary, to carry out the works including all cabling and intermediate connections from supply point to location of work. All wiring, cabling, etc., serving temporary installations are to be designed, installed and operated, as to be safe and in full accordance with the appropriate regulations.

As soon as any part of the Contractor's Site establishment or plant is no longer required for carrying out the Works, the Contractor shall disconnect and remove the same to the satisfaction of the Engineer.

5 PIPEWORK CONNECTIONS

The Contract shall include all pipework and connections to all sanitary fittings, basins and equipment as detailed on the Drawings and Architectural Loaded Drawings.

6 MATERIALS

All materials, plant and equipment shall comply fully with any relevant British Standard Specification or equivalent American standards.

The Engineer reserves the right to inspect materials, plant and equipment on Site at reasonable times and to reject any of the same not complying with the Specifications.

The cost of dismantling and re-erection of the installation occasioned by the removal of rejected materials, plant or equipment shall be borne by the Contractor.

7 STANDARDS

Corresponding parts of all apparatus shall be interchangeable and where mechanical or electrical details are used or which any part of parts are covered by a British Standard or American standards Specification, all such parts are to be made in accordance with such specification as shall be issued at the date at which the parts have been ordered.

Except where otherwise specified, all bolts nuts and stud screws thread shall be metric and all pipe threads to be to B.S. pipe threads standards.

8 TRADE CUSTOMS AND PRACTICE

The Contractor shall be entirely responsible for arranging and ensuring that the various classes of work comply with local trade customs and practice and shall provide accordingly in his Works.

9 DIMENSIONS

The Contractor shall take his own dimensions on Site for all plant and material to be supplied by him and shall be entirely responsible for the accuracy, of his measurements.

10 SETTING OUT

The Contractor shall set out the Works in accordance with his installation working drawings.

11 NAMEPLATES

All plant and apparatus supplied under this Contract shall be provided with brass nameplates, bearing the maker's name shop or reference number, size, type, test and working pressure, speed and other relevant particulars engraved thereon.

12 INTERRUPTION OF SERVICES

The Contractor shall not without permission of the Engineer interrupt or interfere with the operation of existing services such as water, electric lighting and power, buried cables, sewers, drains, etc., nor, in the case of works of statutory authorities or private owners, without the permission of these authorities or owners.

In the event of any such damage, the Contractor shall be responsible for the making good of same to the satisfaction of the Engineer, authorities or owners, as the case may be.

13 MISUSE OF MATERIALS

No materials brought on to Site for incorporation in the Works shall be used for scaffolding or any other temporary purpose.

14 VOUCHERS

The Contractor, at the request of the Engineer, must produce invoices, paid or unpaid, or accounts if required as proof that the goods are in all respect as herein specified.

15 OBSTRUCTIONS

No extra charge shall be made for moving or circumventing any obstruction or other Contractor's equipment that may be laid on the Site and the Contractor must, therefore, allow in his tender for these and any other contingencies likely to arise.

16 INSPECTION, TESTING AND REJECTION

The Employer representative and the Engineer with no extra cost shall be entitled during manufacture to inspect, examine and test the materials and workmanship for all plant to be supplied under the Contract, whether at the Contractor's or manufacturer's premises or on the Site. Such inspection, examination or testing shall not release the Contractor from any obligation under the Contract. The whole of the installation shall be tested on completion (in the presence of and to the satisfaction of the Engineer or his representative)

in the relevant Sections of this Specification as applied to the particular installation concerned.

Certificates of test, in duplicate, must be furnished by the Contractor to the Engineer, for all plant or materials specified to be tested at maker's works.

The tests on Site specified hereinafter are to be carried out in the presence of the Engineer or his Representative. The accuracy of all tests is to be to the satisfaction of the Engineer, whose decision shall be final.

The Contractor shall provide free of charge on the Site at his own expense and/or the manufacturer's works, such labor, materials, apparatus and instruments as the Engineer may consider requisite from time to time and as may reasonably be demanded to efficiently test the plant, materials or works as far as completed, until the plant is accepted as a whole by the Engineer. The Contractor shall at all times give facilities to the Engineer or his authorized representative to accomplish such testing.

The Contractor shall demonstrate, if required, the accuracy of any instrument used for testing.

At least seven days' notice must be given by the Contractor of any test carried out on the Site to enable the Engineer or his authorized representative to be present if they so desire.

Testing of pipes and other apparatus as specified under the various Sections of Specifications may be required to be carried out in parts against testing as a whole and the Contractor must provide accordingly in his tender.

Should the Works on testing not conform to the Specifications, the Contractors must make them so conform at his own expense and, if he fails to do so within a reasonable period, not exceeding fourteen days, the Engineer shall be at liberty to call upon him to remove the defective part and reinstate without cost to the Employer.

17 INSPECTION BEFORE CONCEALMENT

Whenever work subsequently to be concealed, requires inspection or testing due notice of at least seven days shall be given to the Engineer so that inspection may be made or tests witnessed before concealment.

Failure to give due notice may necessitate the Contractor uncover the work and re install it at his own expense.

18 VALVE LABELS

The Contractor shall supply and fix on all valves and stop cocks throughout the system, white ivorine labels with black engraved lettering to provide a clear indication of the precise function of the valve. Each label shall be numbered to agree with the Schedule of Valves and the 'As Fitted' drawings.

19 THERMAL INSULATION - GENERAL

All items of thermal insulation work covered by this Specification shall be carried out by skilled operatives in this field of work approved by the engineer.

The Contractor shall ensure that he is acquainted with all of the Conditions of the Works, specifications, hours of working, completion date(s), etc., at tender stage and he shall complete all Works within the program specified. The thermal insulation work shall not be commenced, unless otherwise approved in writing, until the whole or part of the installation has been completed and tested as set out in the relevant pipework, plant and air distribution Sections of the Specifications.

All thermal insulation shall be as detailed hereafter, unless specifically detailed otherwise under the relevant Clause of the Technical Specifications.

Thermal insulation shall conform to all relevant parts of the building regulations, and to BS 5422, 5970, and American standards.

Insulation materials shall comply with BS 3927 & BS 3958. Thermal insulation of the buried pipes services shall comply with BS 4508.

20 THERMAL INSULATION IN PLANT ROOMS

a) Pipework:

All pipework, as specified under item 2.19 shall be individually insulated with plain performed rigid glass fiber sections 64kg /m^3 density.

The sections shall be applied in 1,200 mm. lengths, cut longitudinally into halves and securely attached - to the pipework, without gaps, by self-adhesive circumferential bands at 300 mm. centers.

Whenever possible, the longitudinal seams shall be of an interlocking 2 type, to ensure a satisfactory joint.

Where the sections are cut and mitered around bends, branches, etc., they shall be fully taped to ensure they are held rigidly on to the pipe.

The thickness of insulation shall be in accordance with Appendix I at the end of this Section of the Specification.

All insulated pipework fittings and valves in all Plant Rooms, carpark, internally wet arias,roof and Tunnel shall then be enclosed in fabricated embossed aluminum cladding. The aluminum cladding shall be not less than 1.0 mm. thick on all pipe sizes.

Cladding shall be applied to bends and branch pipe connections prior to straight lengths as follows:

1) Bends on pipes up to 50 mm. dia. shall be clad by riveted 45° mitered joints.

2) Bends on pipes above 50 mm. dia. but below 100 mm. dia. shall be clad by riveted 3 segment lobster back bends.

3) Bends on pipes of 100 mm. dia. and above shall be clad by riveted 5 segment lobster back bends.

4) Branch pipe connections shall be clad by cutting a serrated edge opened out against the main pipe. A profiled hole to suit in branch pipe shall then be cut in the main pipe straight cladding.

5) Straight pipe cladding shall be rolled to suit the overall insulated pipe dia. and aluminum riveted at 100 mm. centers. The cladding shall be fitted tight to the insulation to ensure a rigid finish. Seams shall be positioned so as not to be generally visible.

All cladding terminations at valves etc., shall be fitted with aluminum end cappings.

b) Pipework Fittings:

All valves, flanges, unions, pump casings and other items requiring access for maintenance on DHW, Steam, and Condensate Pipework, shall be insulated and finished by means of removable 1.0 mm. thick embossed aluminum casings.

The casings shall be fully lined with rigid insulation of the same thickness as that applied to the pipe, securely fixed to the internal surfaces of the box.

The casings shall be split in two halves with one joint suitably hinged and the other securely fixed by quick release toggle fasteners. The casing edges shall be folded so as to give double thickness of aluminum on which to rivet the hinges and fasteners.

Heat bridges between the hot surface and aluminum casings will not be accepted.

Where thermostats, gauges, etc., are fitted the cladding shall be neatly cut and fitted with plain aluminum masking plates.

21 THERMAL INSULATION IN VOIDS SHAFTS AND DUCTS

Where pipes are installed in buildings voids, shafts and ducts and in any position otherwise indicated on the tender drawings, they shall be insulated as follows:

a) Pipework:

All pipework, shall be individually insulated with plain performed rigid glass fiber sections 64kg /m^3 density withaluminum foil Kraft laminate covering secured with an approved adhesive and circumferential joints sealed with tape, all to conform with Class '0' spread of flame.

Aluminum bands shall be applied to all insulation at approx. 300 mm. centers.

Where bends and offsets occur, the insulation shall be tailored to suit.

The thickness of insulation shall be in accordance with Appendix I at the end of this Section of the Specifications.

Polished aluminum and cappings shall be provided to close all insulation terminations.

b) Pipework Fittings:

All valves, flanges, unions and all other items requiring access for maintenance shall be insulated as follows:

1) DHW, Steam and Condensate Fittings on Pipework 40 mm. dia. and above:
Insulated with removable casings as detailed under Plant Rooms, adjoining insulation to be fitted with aluminum end caps.

2) All Other Fittings:
Adjoining pipe insulation to be fitted with aluminum end caps.

22 THERMAL INSULATION EXTERNALLY

Where pipes are installed externally on roof top plant rooms or in external underground trenches or in other wet areas internally, (i.e. showers, bath areas, etc.) and in any other positions otherwise shown on the tender drawings, they shall be insulated as follows:

a) Pipework:

All pipework, carrying hot or cold water and steam, shall be individually insulated with plain performed glass fib resections.

Self-adhesive tape bands shall be applied to all insulation at approx. 300 mm. centers.

Where bends and offsets occur, insulation shall be tailored to suit.

The thickness of insulation shall be in accordance with Appendix I at the end of this Section of the Specifications.

All insulated pipework shall then be covered with 0.8mm thick Polyiso-butylene (PIB) sheeting with 50 mm. overlaps on all circumferential and longitudinal joints. And shall be finally cladded with1.0mm aluminum cladding.

b) Pipework Fittings:

All valves, flanges, unions, etc., on all pipework carrying hot or cold water and steam shall be insulated as detailed in (a) above.

23 THERMAL INSULATION PROTECTION

Any pipework, which is insulated but which is likely to be accidentally damaged during maintenance or in gaining access to an area of void or at low level (constrained at 2 meter high from FFL)of plant rooms, shafts (Open in Tunnel) Tunnel and Roofs etc., shall be additionally protected with 1.0mm. thick aluminum sheeting. Any damage within the contract period, which may occur as a result of non-compliance with the requirements, shall be made good at no cost to the Employer.

24 PAINTING, GENERAL

All items of painting covered by this section of the Specifications shall be carried out by skilled Operatives in this field of work approved by the engineer.

The contractor shall ensure that the specialist painting contractor is acquainted with all the conditions of the work, specification, hours of working, completion date(s), etc., and he shall complete all Works within the program specified. The painting work shall not be commenced unless otherwise approved in writing, until the whole or part of the installation has been completed and tested as set out in the relevant pipework, plant and air distribution of the Specification.

All painting shall be as detailed hereafter, unless specifically detailed otherwise under the relevant Clause of the Technical Specification.

All painting materials shall be as manufactured by an approved manufacturer and shall be delivered in sealed containers, clearly labeled with type of material and intended use. The following surface treatments shall be applied to all areas detailed under this Section of the Specification unless stated elsewhere in the Specifications.

25 TYPES OF SURFACE TREATMENT

a) Method 1:
The surface shall be thoroughly wire brushed degreased and given one coat of primer as the installation proceeds.

b) Method 2:
The surface shall be hot dip galvanized in accordance with B.S.729. After installation, the surface shall be thoroughly degreased by solvent washing followed by one coat of undercoat/primer to suit the final coat of HIGH BUILD ALKYD Gloss to suit the Engineer's color scheme for the B.S.4800 range of colors.
Any damage caused to the galvanizing by burning or cutting shall have all weld splatter and swarf removed and patch primed prior to the paint system detailed above.

c) Method 3:
Shot blast all surfaces to SA 2.5 at manufacturer's works and within 4 hours (or before corrosion sets in, whichever is the sooner) apply one coat of Zinc Phosphate Primer 2-1-10 to 75 micron thickness and one coat of Micaceous Iron Oxide 2-4-01 to 60 micron thickness.

After installation apply one coat of Micaceous Iron Oxide 2-4-01 to 60 microns thickness, followed by one coat of High Build Alkyd Gloss to suit the Engineer's color scheme from the B.S.4800 range of colors.

d) Method 4:
The surface shall be shot blasted to SA 2.5 to give a minimal profile (maximum profile 50 microns) followed by one coat of HT Silicone Aluminum paint in the manufacturer's works.

Any damage to the treatment caused in transit or installation shall be made good.

e) Method 5:

The surface shall be wire brushed and degreased, painted one coat of primer as installation proceeds, followed by one coat of undercoat/primer to suit the final coat of High Build Alkyd Gloss to suit the Engineer's color scheme from the B.S.4800 range of colors.

f) Method 6:
The surface shall be painted with one coat of High Build, suitably thinned with thinners, followed by one coat of Spread Valve Undercoat to suit the final coat of High Build Alkyd Gloss to suit the Engineer's color scheme from the B.S.4800 range of colors.

26 PAINTING IN PLANT ROOM

a) All uninsulated pipework,flanges, unions, valves, trench covers and handrails shall be treated as Method 5.

b) All steel pipework to be insulated shall be treated as Method 1.

c) All pipe support to be galvanized shall be treated as Method 2.

d) Supporting steelwork for hoppers, gantries, hotwells, silos, tanks and all other structural steelwork shall be treated as Method 3.

e) All black steel hotwells, hoppers, silos, tanks and other fabricated mild steel equipment not detailed elsewhere shall be treated as Method 3 unless stated otherwise elsewhere in the Specifications.

f) All equipment and plant delivered to site in a prefinished condition shall have all damage made good prior to handover.

27 PAINTING IN VOIDS, SHAFTS AND DUCTS

a) All uninsulated pipework shall be treated as Method 5.

b) All steel pipework to be insulated shall be treated as Method l.

28 PAINTING EXTERNALLY

Painting externally shall be in accordance with that detailed for Plant Rooms with the following exceptions:

Where supports are installed in concealed positions, i.e. underground trenches and tunnels trenches etc, they shall be hot dip galvanized only.

29 PROTECTIVE PAINTING

Provide a heavy field coat of black asphalt paint on all steel pipe, cradles, vibration isolating mounts, and the like, that will be encased or partially encased in building construction, set in cement or fill, before items are built into the general construction. Kitchen range hood ducts and boiler breeching shall be painted with heat resistant paint.

Coat interior of each outdoor air chamber with two coats of odorless, rust resisting, nonscaling paint.
Coat interior of ducts at register boxes with two coats of black paint, to a dull finish.

All pumps, motors, and all other factory manufactured and assembled apparatus shall be factory coated with one coat of primer and one coat of machinery enamel, and after installation shall be cleaned and touched up to repair any damage incurred during construction.

30 MECHANICAL IDENTIFICATION

A. GENERAL

- Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

- Submit manufacturers catalog literature for each product required.

- Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

- Submit two tags, labels, pipe markers suitably sized for the project.

- Indicate installation instructions, special procedures, and installation.

- Record actual locations of tagged valves; include valve tag numbers to be part of Project Record Documents.

B. IDENTIFICATION MATERIALS SHALL BE AS FOLLOWS:

1. NAMEPLATES

Laminated three-layer plastic with engraved black letters on light contrasting background color.

2. TAGS

2.1 Plastic Tags:
Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 38 mm square

2.2 Metal Tags:
Brass with stamped letters; tag size minimum 38 mm square with finished edges.

2.3 Information Tags
Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 83 x 143 mm with grommet and self-locking nylon ties

2.4 Tag Chart:
Typewritten letter size list of applied tags and location in anodized aluminum frame.

3. STENCILS

3.1 Stencils: With clean cut symbols and letters of following size:
- Up to 51 mm Outside Diameter of Insulation or Pipe: 13 mm high letters.
- 64-150 mm Outside Diameter of Insulation or Pipe: 25-mm high letters.
- Over 150 mm Outside Diameter of Insulation or Pipe: 44 mm high letters.
- Ductwork and Equipment: 44 mm high letters.

3.2 Stencil Paint: As specified in Section 09900, semi-gloss enamel, colors and lettering size conforming to ASME A13.1.

4. PIPE MARKERS

4.1 Color and Lettering: Conform to ASME A13.1.

4.2 Plastic Pipe Markers:
Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

4.3 Plastic Tape Pipe Markers:
Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings

4.4 Plastic Underground Pipe Markers:
Bright colored continuously printed plastic ribbon tape, minimum 150 mm wide by 0.10 mm thick, manufactured for direct burial service.

5. CEILING TACKS

5.1 Steel with 19 mm diameter color-coded head.

5.2 Color code shall be green for plumbing valves

6. LABELS

Aluminum, size 48 x 19 mm, adhesive backed with printed identification and bar code.

7. LOCKOUT DEVICES

7.1 Lockout Hasps:
Anodized aluminum hasp with erasable label surface; size minimum 184 x 76 mm.

7.2 Valve Lockout Devices:
Steel device preventing access to valve operator, accepting lock shackle.

C. INSTALLATION

- Install identifying devices after completion of cleaning surfaces, coverings and painting.

- Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.

- Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer.

- Install tags using corrosion resistant chain. Number tags consecutively by location.

- Install underground plastic pipe markers 150 to 200 mm below finished grade, directly above buried pipe.

- Identifyboiler, pumps, tanks, and compresssors with plastic nameplates.

- Identify control panels and major control components outside panels with plastic nameplates.

- Identify valves in main and branch piping with tags.

- Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 20 mm diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 6 m on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

- Provide ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

31 CLEANING

Due allowance shall be made for the full and proper protection of all items of plant and equipment, electrical installation and building structure during the whole of the application of the insulation and painting works.
Any damaged insulation/paintwork shall be replaced at no additional cost to the Employer.

32 INSTALLATION OF PIPED SERVICES

Installation of all pipework shall follow the detail set out in the accompanying drawings and be in accordance with the best accepted practice.

Details set out in the following Clauses of this Section are generally appropriate to all services except where specifically stated elsewhere in the Specifications and Drawings.

All exposed pipe runs shall be arranged to present a neat appearance and, where practical be parallel both with one another and with the building structure, taking due regard however to the grading, venting and draining requirements. All vertical pipes shall be plumb.

All exposed pipe runs shall be arranged so that the longest length of tube practicable is used between bends, tees and flanges or unions. Short lengths of tube joined together by sockets shall not be permitted.

All pipework, valves, fittings and equipment forming the piping installations shall be erected so that it can be dismantled and is accessible for repair and replacement. In this context, 'accessible' means that the provision for dismantling the flange, union, etc. can be reached and worked upon either in the open or else by removal of a purpose-made duct cover, manhole or similar cover; the fitting is "not accessible" if, as fixed, it cannot be manipulated.

Flange adapters and grooved coupling shall be provided at valves and equipment so that they can be dismantled. No pipe shall be installed without a flange adapter or grooved coupling at a point where it passes through a wall, floor or ceiling and is not readily removable.

No joints shall be formed within the thickness of walls. floors or ceilings.

To facilitate routine maintenance, the position of all valves, drains and supports shall be determined with this aspect in mind. Grouping of valves, drains, unions, flanges etc. shall be preferred to scattered sitting.

Clearance between pipework and finished walls, floors, ceiling and other fixtures should be adequate for cleaning purposes and future dismantling, and shall not be less than the distance given below:

Pipework to floor - minimum distance 100 mm.

Pipework to ceilings - minimum distance 100 mm.

Pipework to walls - minimum distance to conform with standard bracket centers

Pipework to pipework - minimum distance 32 mm.

The Contractor shall include for bends in pipes round piers and all other projections and recesses and for all offsets due to varying thickness of plaster, walls, floors, ceilings, and other structural works. It shall be the responsibility of the Contractor to ascertain the skirting heights, sill heights and floor finishes. No pipework offsets shall be allowed on pipework visible in rooms, except as agreed with the Engineer.

Where pipes are held in vices, as when screwing or cutting, care shall be taken to ensure that the pipe surface is not damaged. Any pipework so damaged shall not be fitted. Any pipework surface damaged by scoring whilst being installed, shall not be accepted.

The Contractor shall ensure that all pipes, fittings, valves, etc. are free from corrosion and internal obstruction. Pipes and fittings showing signs of corrosion shall not be fitted.
The Contractor shall protect the open ends of all pipework. Suitable caps, plugs or plastic covers only shall be used to cover open ends. Wood, rag or paper plugs shall not be used.

The Contractor shall not use a valve fitted to the open ends of a disconnected pipe to prevent the entry of dirt.

Failure to comply with the above instructions shall mean that the Engineer shall have the right to order the pipework to be dismantled for as far as considered necessary and the pipework to be thoroughly cleaned internally.

The Contractor shall carry out this work free of cost to the Employer and shall bear all costs incurred by removing, cleaning and replacing the sections of pipework.

Pipework shall be erected to neatly follow the lines of walls, floors, tunnels and trenches and be correctly graded to ensure venting and draining down can be achieved. Manual valved air vent lines shall be installed at all high points. The clearance between pipework (or if lagged, the lagging) and walls, floors or any other fixtures shall be not less than 100 mm. Pipe drops shall be vertically plum. All horizontal and vertical adjacent pipework shall be installed parallel to walls and floors except where gradients for venting and draining dictate otherwise.

Headers, where indicated shall be arranged so that each circuit isolating valve is connected direct to a vertical outlet on the top of the header. Circuit connections such as thermometers, flushing valves and circuit isolating valves shall be arranged at common horizontal levels.

Distribution headers up to and including 50 mm. installed on closed circuit recirculation systems shall have the ends terminated with a screwed cap or plug.

Distribution headers above 50 mm. on closed circuits and on open circuits shall have the ends terminated with a grooved end caps onto the pipe, and a blank flange bolted to it.

Curved or long sweep bends and branches shall be provided as far as is practicable. Square elbows will not be permitted.

Wherever practicable, made bend and sets shall be furnished in preference to short radius fittings. Bends and sets in black pipework above 50 mm. diameter shall be hot formed having a radius not less than four times the pipe diameter. The tubes must remain circular after setting.
Long sweep branches with gradual reductions shall be used for reduced diameters where two mains connect together.

Exceptions to the above shall be used where air pipes or air bottles, drain or dirt pockets, are taken off or air venting requirements dictate, in which case square connections and fittings may be used.

Special care shall be taken where branch joints, welded joints, basses, vents and drain pockets are made, to ensure that there is no obstruction or possible cause of obstruction and to see that full bore is maintained in all directions.

1- All branch connections shall be taken from top, side or at a 45° angle from all horizontal piping. Bottom connection shall not be allowed without special flushing provisions being made. When taking side connections from horizontal mains adequate facilities for draining shall be provided.

2- The distance between any two adjacent branches shall not less than the sum of the outside diameters of the branches.

Reduction in sizes of pipe lines shall be made by reducing mechanical coupling.

33 PIPEWORK MATERIALS

All pipework installed by the Contractor shall conform with the specified materials, specified under the relevant sections and BOQ items.

34 MILD STEEL PIPEWORK

Where the table of pipework materials requires the use of mild steel pipework, black or galvanized, this shall be straight, cleanly finished, round in cross section, free from cracks, surface flaws, lamination and other defects and shall be free from rust and scale.

Steel Pipe Wall Thickness

Nominal Pipe Size	Wall Thickness (MM)	Nominal Pipe Size	Wall Thickness (MM)
(MM)	Sch. 40	(MM)	Sch. 40
15	2.77	100	6.02
20	2.87	150	7.11
25	3.38	200	8.18
32	3.55	250	9.27
40	3.68	300	10.31
50	3.91	350	11.10
65	5.15	400	12.70
80	5.49	450	14.27

Steel pipes, which are to be used 'black', shall be varnished externally throughout their length after manufacturer.

Where steel pipes are to be installed underground, they shall be double wrapped in special tape and nylon suitable for the application.

35 COPPER PIPEWORK

Where the table of pipework materials requires the use of copper pipework, this shall be solid drawn from phosphorous deoxidized non-arsenical copper to free from any deleterious film. Copper Pipework used shall be in accordance with ASTM standards type "L"

All piping and tubing used in the installation described in this Specification shall be straight, cleanly finished, round in cross section, free from cracks, surface flaws, laminations and other defects.

36 CPVC PIPE WORK

CPVC pipes and fittings shall be provided for all cold, hot water and return hot water pipes running on the roof , carparks, in the risers, from the ground tank and at high level inside the building above false ceilings and where ever shown in the drawings .

CPVC pipes and fittings shall be provided also for all condensate pipes.

The CPVC pipes and fittings shall be from the same manufacture.

Date of manufacturing for pipe and fittings shall not be more than two years of date of the submittal

The CPVC pipes shall pass the tests from the Royal Scientific Societety Labs , a random samples from the site will be taken for tests , all expenses for the tests shall be upon contractor responsibility and will be paid directly from him .

Pipes pressure shall be 25 bar for cold & hot water pipes, pipe pressure shall be 16 bar for condensate pipes.

All CPVC pipes and fittings which are exposed to the sun and inside car parks shall be insulated by closed cell expanded rubber 12mm thick, density 65-80kg/m^3. Insulation shall be chemical and oil resistant, self extinguishing, and shall withstand a temperature ranging from 40°C to 120°C, and shall be protected by smooth aluminum cladding of 1mm thickness; the insulation and aluminum cladding shall be included in the prices of CPVC the pipes in the B.O.Q.

A primer for CPVC pipes and fittings, shall be used before using CPVC solvent.

All sizes for CPVC pipes, fittings and expansion joints shown on the drawing and B.O.Q are according to Din standards or ISO 15877 Standard .

37 Sanitary Distribution Pipework

The sanitary pipework for cold water and hot water distribution from the water distribution main domestic cold and hot water cpvc pipes above false ceilings to the sanitary fixtures shall be cross linked polyethylene plastic pipes, Pex/a or Pex/c, and manufactured to DIN 16892/3 with a working temperature of 95°C at 10 bar, and 20°C at 20 bar, and shall comply with and approved by DVGW (Germany).

The outside diameter of all pipes supply sanitary fixtures shall be as mentioned on drawings.

The pipes shall run in conduits (sleeves) to each individual outlet without using any fittings along to the sanitary fixtures

The sleeves shall be of smooth polyethylene pipe of 32mm dia for 16mm and 20mm pipes.

The pipes shall be flexible type delivered coiled.

The gap between the conduit and the pipe connected to the manifold outlet shall be sealed with approved rubber ring.

The connections of PEX pipes to the tapes, mixers etc., shall be made using brass elbow/adapter, housed in PVC box (Termination Box) built inside the wall. The boxes shall have provision for incoming flexible conduit.

The termination box shall have compression connection for PEX pipe on one side and female thread for the sanitary fixtures on other side .

The complete assembly shall be such that the PEX pipe can be withdrawn and replaced without damaging the wall finish , a brass crome plated ball valve shall be installed between the main domestic cold and hot cpvc pipes and each cross linked polyethylene plastic pipe branch .

38 JOINTING OF MILD STEEL PIPEWORK

Black mild steel pipework up to and including 50 mm dia. shall be jointed by screwing joints.

Black mild steel pipework of 65mm. dia. and above shall be jointed by mechanical grooved joints.

All galvanized steel pipework shall be screwed or jointed by mechanical grooved joints, same as black steel pipes.

All mechanical grooved joints shall be fastened by flexible mechanical couplings; except for fire fighting pipework they shall be rigid coupling.

All screwed black steel pipework shall have provision made for dismantling, using unions.

Galvanized mild steel pipework up to and including 50mm. dia. shall have provision made for dismantling using galvanized malleable iron unions.

Galvanized mild steel pipework of 65- mm. dia. and above shall have provision made for dismantling using galvanized mechanical couplings.

39 JOINTING OF COPPER PIPEWORK

Copper pipework up to and including 40mm. dia. shall be jointed using capillary silver brazing fittings.

Copper pipework above 40mm dia. shall be jointed using led free bronze grooved mechanical couplings and fittings according to ASTM (B-584).

During all jointing operations the fitter/plumber shall be accompanied by a competent assistant and suitable asbestos mats shall be used to protect the building fabric and decorations.

Every precaution shall be taken to prevent damage by scorching or fire, and the Contractor shall provide the fitters/plumbers with two portable fire extinguishers for use in an emergency.

40 MECHANICAL COUPLINGS

All pipe of suitable of wall thickness for sizes above 65mm for mildsteel pipes and 40mm for copper pipes may be jointed by using of mechanical wall grooved pipe and coupling on services with working temperatures not to exceed 85ºC. This shall include the following building service piping systems:-

Fire Protection

- Fire Standpipe - Wet and Dry
- Automatic Sprinklers - Wet
- Water Supply (domestic hot and cold copper pipes)

Installation shall be operative trained by the manufacturer.

Mechanical coupling shall be used for all grooved pipes, valves, fittings and other grooved component.

All grooved joints shall be jointed by mechanical rigid or flexible couplings.

Couplings shall be of cast ductile iron confirming to ASTM A-536 and shall be UL listed and FM approved for fire fighting pipework and shall be bronze confirming to ASTM (B-584) for domestic cold and hot pipework.

The joints shall be self-centering and comprise coupling pieces, sealing gaskets, special nuts and bolts.

Grooves shall be formed at the end of the pipe by machine to manufacturer's instructions. Grooves shall be dimensionally compatible with the coupling

Joints shall made to the manufacturer fitting constructions. Earthing continuity clips shall be fitted at every point.

41 SCREWED JOINTS

Screwed joints shall be tapered to B.S.21, or to ANSI B1.20.1.

Steel pipes having screwed joints shall be carefully reamed out before the plain end is screwed.

When making a joint, the screw thread shall be coated with a white jointing compound to B.S.5292 and good quality hemp, all surplus jointing compound being finally cleaned off to leave a surface suitable for painting. P.T.F.E. tape may only be used with the prior agreement of the Engineer.

The joint shall be arranged so that on completion two or three threads are left showing.

Should a screwed joint prove defective under subsequent test, caulking shall not be allowed.

42 WELDED JOINTS (FOR STEAM PIPEWORK)

Steel pipes, having welded joints on the run, shall be prepared for jointing in a manner suitable for the technique employed. Welding shall be carried out in accordance with R.S.2971 for metal arc welded joints, using covered electrodes and B.S.1821:1957 and B.S.2640:1955 for oxy-acetylene welded joints.

Pipes shall be prepared for welding with ends swan or cut off by hand, flame cut by hand with subsequent truing up by filing or by grinding to a bevel of 37.5" as may be required. Welding rods shall in all cases be of good quality copper coated low carbon steel and the manufacturer shall provide test certificates representative of the rods in accordance with B.S.1453: 1972. Group A.

All pipework shall be reamed after cutting to ensure it is free from rust, burns, scale and other defects and shall be thoroughly cleaned before erection.

All welded joints, produced by the oxy-acetylene flame process, shall be of best quality, the butt being slightly convex with regular ripples and no undercutting, washing away or surface cavities being resent. Notches at the root indicating incomplete penetration and excessive weld protruding into the pipe bore in

excess of 1.5 mm. shall not occur and the external reinforcement shall run out smoothly to the pipe surface on either side.

Welding shall in all cases be carried out by skilled craftsmen, who are in possession of a current certificate of competency issued by an approved authority (which shall be produced at the request of the Engineer and have had a suitable period of experience for the class of work in which they are engaged in accordance with B.5.4871 and B.S.4870.

Highly skilled non-certificated welders may only be used by written permission of the Engineer and test welds, in accordance with R.S.4870, Part l, 1972 with satisfactory laboratory test certificates, shall be submitted before this permission is granted. The Engineer shall determine a suitable independent testing authority and any costs arising from these tests shall be borne by the Contractor.

During all welding or cutting operations, the welder shall be accompanied by a competent assistant and suitable asbestos mats shall be used to protect the building fabric and decorations.

Every precaution shall be taken to prevent damage by scorching or fire, and the Contractor shall provide the welder with two portable fire extinguishers for use in an emergency.
After cutting or welding, all flashings shall be removed from all pipework before erection.
All welded joints shall be painted two coats of red oxide on completion of the joint.

43 FLANGED JOINTS

Flanges on black mild steel pipes shall be of flange adapter suitable for mechanical grooved system.

Flanges on galvanized mild steel pipes shall be of the galvanized flange adapter suitable for mechanical grooved system.

Flanges on capper pipes shall be of copper flange adopters and suitable for mechanical groove system

44 FITTINGS FOR STEEL PIPEWORK

Fittings for all mild steel pipework up to and including 50 mm. dia. shall be malleable cast iron pipe fittings to B.S.143, or ANSI B16.3, with the exception of steam pipework on which wrought steel pipe fittings, manufactured from mild steel by seamless or welded process to B.S.1740 shall be used.

Fittings on galvanized pipework shall be galvanized to B.S.729, Part 1.

The screwed ends of the fittings shall be provided with parallel female and tapered male threads to B.S.21, Part 1, the axis of thread being coincident with the true axis of the fittings. Where required, taper threaded fittings shall be provided and shall be in accordance with B.S.143.

Fittings on black mild steel pipework of 65mm. dia. and above shall be grooved end fittings and shall be UL approved and FM listed.

In addition to the fittings set out in the standards, branch bends manufactured to the same details may be used.

Ends of fittings, which shall have the same wall thickness as that of tube shall be beveled for butt-welding where welding joints used.

Generally all fittings shall, where practicable, be of the easy sweep type. Branches shall be made using swept tees or branch bends except where an air lock is liable to form i.e. tees on rising mains, etc., where square tees shall be used.

Elbows shall be used only where the use of bends is impracticable and where the Engineer's permission has been obtained.

Where standard fittings are not available for the duty required, reductions on the run and to the branch shall, in all cases, be made with reducing sockets not bushes.

Reducing fittings on horizontal pipework shall be of the eccentric pattern fixed so as to give a smooth run to the crown of the pipe. Concentric pattern reducers shall be used on vertical pipework.

The diameter shall be maintained; crinkled and scored work will not be accepted.

Where junctions to steel mains are formed by factory or site welding, such work shall be carried out to the above standards for steel tubular. All necessary reinforcement by way of plates, collars or shoes shall be provided. All branch bends, where possible, shall be formed by the use of special welding fittings of the same quality as the pipe and shall conform to B.S.1965:1963 and amendments.

Where branch bends are used, the profile of the hole shall be carefully set out to match the fitting and where the holes are flame-cut all loose scale and oxide shall be removed from the main before the branch is welded into position.

The distance between the centers of two adjacent branch welds shall not be less than twice the diameter of the large branch. All changes in direction shall be proportioned so that the ratio between the center line radius of the bend and the inside diameter of the pipe is not less than 1.5: 1.

Lobster back and cut and shut bends will not be permitted.

Unions shall, in all instances, be manufactured with double gunmetal seats.

45 FITTINGS FOR COPPER PIPEWORK

Capillary fittings shall be to ASTM standard suitable for type "L" pipes. All fittings shall be manufactured from materials being non-dezincificable, i.e. copper or gunmetal.

Silver brazing fittings shall be manufactured from copper according to ASTM standards.

All fittings shall be suitable for the working conditions of the system and purpose-made fittings shall be used throughout. All branch connections shall be by purpose made tees, either square or sweep, to suit the application.

Where practical, fittings shall be of the long sweep pattern. Where standard fittings are not available for the duty and sizes required, reductions shall be made with purpose-made fittings.

In all cases, tubes shall be loaded prior to bending with springs, low melting point alloys or an inert sand, care being taken that contamination of the tube material is avoided.

No pulled bends with any deformity whatsoever resulting in the forming of the bend shall be permitted.

Unions shall be manufactured from gunmetal and shall be according to ASTM standards. For sizes above 40mm grooved end copper or gunmetal fittings shall be used.

46 FITTINGS FOR CPVC PIPEWORK

All fittings used onCPVCpipework shall be made from CPVCfrom the same pipe manufacturer and according to the same standards of the CPVC pipesand shall have a working pressure of 25 Bar.CPVC jointing shall be as the manufacturer recommendations.

47 SUPPORT SYSTEM

1. Mechanical Supports & Duct hangers.
2. Thermal expansion –Sliding Elements.
3. Riser Pipes.
4. Passive Fire Prevention System.
5. Tables

1 MECHANICAL SUPPORTS AND HANGERS

1.1 All installation material used for supporting and fixing Mechanical Pipe systems should be of a modern type that gives tested reliable supporting solution without the need for welding, drilling or subsequent galvanizing for corrosion protection.

1.2 The Mechanical Installation system should consist of the following components:

1.2.1 C-Channels should be used as the main item for supporting all pipes. C-Channels should be made of rolled steel strip as per DIN standard. The steel is Sendzimir Galvanized to a thickness of 20 microns. Contractor must submit mechanical drawing showing all support locations combined with detailed load calculation. Where the channel is cut, suitable end caps should be used to protect the cut from corrosion. C-Channels of minimum thickness of 2mm and width of 40mm shall be used all applications, and the height to be selected according to load calculation.

1.2.2 C-Channel accessories as recommended by the channel manufacturer, should be used to assemble various channel structures as appropriate for the application. These accessories

include single-part components for attaching connectors, fixing nuts with serration, angles, brackets and pipe ring saddles. All galvanized.

1.2.3 Pipe Ring Clamps: For hot, cold domestic pipes; galvanized, pre-engineered pipe ring clamps should be used for fixing all pipes to channel system or directly to the correct structure. The contractor should verify that the pipe supported weight does not exceed the recommended maximum load of the clamp as provided by manufacturer. The pipe rings should be of a double screw type. Medium duty pipe rings shall be used for pipes up to 3 inch size and heavy duty pipe rings shall be used for sizes 4 inch and above except for the fire fighting system, the vertical pipes shall be supported by heavy duty double screw pipe rings without rubber and shall UL listed, all pipe rings used for copper pipes and hot-chilled water steel pipes should be provided with a pre-fitted rubber inlay;

1.2.3.1 Rubber inlay: made of EPDM material inspected for sound insulation as per DIN 4109, temperature resistance from(-40 to +110) ◌̊C.

1.3 Threaded Rods used should be manufactured as per DIN standards of steel Grade 4.6, The Threaded rods, nuts and flat washers used should have a clean thread and flawless galvanized condition.

1.4 Concrete anchors: should be internally threaded for fixing rods, made of galvanized zinc plated and passivated steel. Anchor should have FM, VDS and fire resistance approval.Zinc plated and passivated steel bolt anchor with suitable diameter should be used for fixing channels into concrete.

2 THERMAL EXPANSION SLIDING ELEMENTS

Hot water ,steam pipes are subjected to thermal expansion due that sliding gliders or saddles should be used to prevent a build-up forces at the pipe clamp and the fixing points, the glider /saddle should provides a sufficient slid way distance according to the manufacturer load limit and movement limit.

3 RISER PIPES

Special fabricated steel arms should be used to be supported on slap as cantilever and to be welded on pipe sides to hold the riser pipe weight for details see support drawing.

4 PASSIVE FREE PREVENTION SYSTEM

4.1 All openings through walls, ceilings and floors due to penetrations of mechanical installation as well as those due to construction joints, should be sealed with fire rated products suitable for the specific application as specific application as specified here under.

4.2 The product shall be capable of stopping the passage of fire, air and water through wall, floor and ceiling penetrations, cladding, and

expansion joints. The product shall exhibit the minimum designed fire resistant properties.

4.3 The products shall be obtained from an approved, established, and proven firm and quantities shall be applied strictly in accordance with the written instructions of the manufacturer and to the approval of the engineer.

4.4 The recommended treatments for application shall be as follows:

4.4.1 Metal pipe and duct crossings: the annular space around the pipe shall be packed with fire rated from backing material and the ends shall be filled and sealed with fire rated elastic sealant according to manufacturer data. The size of the circular opening shall be maintained as the barest minimum as recommended by the sealant manufacturer.

4.4.2 Non-metal pipe and conduit crossings less than 50mm in diameter: The annular space around the pipe shall be packed with fire rated from as backing material. The ends should then be filled and sealed with, fire rated sealant.

The circular opening shall be maintained strictly minimum recommended by sealant manufacturer.

Pipes/Conduit shall be wrapped and applied strictly according to the manufacturer's specifications.

5 ALL PIPE AND DUCT SUPPORT SPACING SHOULD BE INSTALLED AS FOLLOWS:

5.1 Support galvanized threaded steel piping as follows:

PIPE MATERIAL	PIPE SIZE (mm)	THREADED ROD DIA.	HORIZANTAL PIPES (m)
Galvanized steel Threaded	15 – 25	8mm	1.2
	32	8mm	1.6
	40 – 50	8mm	1.9
	65– 108	10mm	2.2
	125	10-12mm	2.5
	150	10-12mm	2.6

5.2 Support black steel seamless sch 40 piping as follows:

PIPE MATERIAL	PIPE SIZE (mm)	THREADED ROD DIA.	HORIZANTAL PIPES (m)
Black steel seamless Welded	15	8mm	1.6
	20 – 32	8mm	2.0
	40 – 65	8mm	2.7
	80	10mm	4.5

	100	10mm	5
	125 – 150	10-12mm	6
	200 – 300	12-16mm	7

5.3 Support Copper pipes as follows:

PIPE MATERIAL	PIPE SIZE (mm)	THREADED ROD DIA.	HORIZANTAL PIPES (m)
Copper	8 -12	8mm	1.0
	15 - 20	8mm	1.3
	25 - 40	8mm	1.7
	50	8mm	2.2
	65 - 80	10mm	3.3
	100	10-12mm	4.0

5.4 SupportPE pipes as recommended by manufacturer.

5.5 Support PP-RCT pipes as recommend by manufacturer.

5.6 Support PVC pipes as follows:

PIPE MATERIAL	PIPE SIZE (mm)	THREADED ROD DIA.	HORIZANTAL PIPES (m)
PVC	40	8mm	0.6
	50	8mm	0.7
	75	10mm	0.8
	100	10mm	1.0
	150	10-12mm	1.2

* Spacing between pipe supports may be decreased as per the manufacturer of the pipe supports recommendation.

48 EXPANSION AND CONTRACTION OF PIPEWORK

Expansion and Contraction of Pipework, expansion joints, guides, and anchor points, as required, whether or not shown on the drawing shall be installed at structure expansion joints and where required to resist the maximum stresses of the pipework, formed by the Contractor.

a) Expansion Joints

Expansion joints shall be of the straight bellows type and of axial pattern or as otherwise indicated. They shall be provided with screwed union or flanged or grooved ends as appropriate to facilitate replacement unless otherwise approved. They shall incorporate internal liners if required and shall be manufactured from 18/8 stainless steel and shall be designed to withstand the test pressure of the system. Bellows shall be capable of not less than 2,000 complete cycles of movement over the designed working range without failure. Pipework supports shall be arranged as near as possible to the joints.

Expansion joints shall be selected to accommodate the maximum working temperature and temperature range of the systems. Rods or hangers shall be provided to take imposed end thrusts.

Joints up to 38 mm. shall have screwed ends to B.S.P. and 50 mm. and upwards flanged ends to B.S.10/4504. All compensators shall be installed in accordance with the manufacturer's recommendations.

All expansion joints shall be provided with external protection where exposed to damage. For axial joints this shall comprise an external sleeve. Joints shall be installed so that they are not subjected to stresses other than those for which they are designed. Unless otherwise indicated they shall be installed so that they are in their free position at a temperature midway between the high and low limits of normal service.

All connections between bellows and pipework shall be aligned prior to and during welding by means of welding clamps.

Axial joints shall be installed in line with the axis of the pipe and shall not be subjected to any tension during installation other than that approved by the manufacturers.

Flanged joints shall be pulled up diagonally across the flanges by means of long bolts after the joints are made the long bolts shall be removed diagonally one at a time and replaced with standard bolts, nuts and washers.

Joints with flanged ends shall be installed during the erection of pipework if possible. Otherwise, temporary distance places of accurate dimensions shall be provided. Each such distance piece shall be exactly equal to the "installed" length of the compensators and shall have flanges precisely square with the pipe and flange bolt holes of the compensator. All expansion joints shall be securely locked in position prior to and during hydraulic testing. Should joints be unable to withstand test pressures they shall be isolated from the piping systems.

Axial expansion joints shall be cold drawn during installation to an agreed amount not exceeding the manufacturer's recommendations.

When installing expansion joints, the manufacturer's installation recommendation shall be observed in every respect.

When pressure testing pipework distribution mains, the Contractor shall ensure that the test pressure will not damage the bellows, where the test pressure exceeds the maximum operating pressure.

All cleats, brackets and steel work required for building-in shall be supplied by the Contractor, unless stated otherwise elsewhere in the Specifications.

Details of all anchors shall be submitted to the Engineer for approval before manufacture.

The bellows shall be installed with due allowance having been made for cold draw, which will vary according to the type and length of bellows proposed and the temperature of installation. Where "installation bars" or fittings are incorporated with the bellows during delivery and erection, these must be removed before heat is applied.

Care shall be taken when installing flanged end bellows to line up the bolt holes on joint and mating flanges and to ensure that the joint is not twisted in any way or any torsional stress applied.

b) Guides

Free guide sleeves shall be fitted on each side of the expansion joint, unless such joint be installed adjacent to an anchor point when guides shall be fitted on the free side only.

Guides shall consist of a tube of diameter not more than 3 mm. greater than the outside diameter of the main and length four and a half times the diameter of the main with a minimum length of 300 mm. unless an alternative design is shown on the Tender Drawings.

Guides shall be installed not more than one and a half pipe diameter from the expansion joint to the first tubular guide and not more than 15-20 pipe diameters between this guide and the next pipe support.

Further pipe guides shall be provided along each pipeline at intervals equivalent to not more than 75 pipe diameters and where shown on the Drawings.

The Contractor shall provide all necessary pipe guides to prevent long pipe spans from buckling and to ensure alignment and linear free movement of pipes from anchor points towards expansion joints constructed to prevent transverse movement and carefully installed so that axial movement is not hampered. Means for lubrication shall be provided where necessary.

Each pipe guide on sections of pipework incorporating axial joints shall be of the tube type with rods tack welded to the guide, and arranged to locate and restrain the pipe in all planes.

Special supports and fixing accessories shall be provided at all heavy items of pipeline equipment i.e. valves, etc. to ensure that no undue strain is placed upon the pipeline at their incidence.

After fabrication, all ferrous fixings and supports shall be thoroughly wire brushed to remove dirt, scale, rust etc. and then given two coats of red oxide primer prior to bolting to or building into the building structure.

Detailed drawings of pipe guides and supporting frames shall be submitted to the Engineer for written approval prior to manufacture.

49 GRADING OF PIPEWORK

All pipework shall be installed with continuous grading to allow for drainage and/or air venting according to the service concerned. Gradients shall be generally as follows for the various services.

- Heating Branches: l in 250 Condensate 1 in 125/250

			Steam	1 in 250
-	DHWS and all CWS:	1 in 750	Comp. Air	1 in 125
-	Gas:	1 in 250		

50 AIR VENTING OF SYSTEM

Full provision shall be made by the Contractor for air venting of the system at all high points in pipework formed by the Contractor, whether or not shown on the drawings.

Automatic air vents shall be used where indicated on the Tender Drawings and where necessary and shall have gunmetal bodies with not less than 15 mm. connection copper or stainless steel floats, guides and non-corrodible needle valves. In all cases, the air vent shall be preceded by a lock shield pattern stop valve and a strainer and the discharge from the air vent shall be 10 mm. copper pipe, which shall discharge to outside in a position which shall be agreed in advance with the Engineer.

The automatic air vents shall in all ways be suitable for the pressure and temperature of the system on which they are to be installed.

Pipework shall be arranged as to allow air to be vented out of the system through air handling units, fan coil units, etc. Also at high points, an air bottle with needle valve shall be installed.

Air bottles in pipework up to and including 80 mm. bore shall be manufactured from 50mm bore pipe, 100 mm. bore and over from 100 mm. bore pipe. All bottles shall be 250 mm. long with welded end caps and be complete with 8 mm. bore copper pipe brought down from the top of the air bottle to within reach of ground or floor level and fitted with 8 mm. lock shield needle valve complete with key.

Where required by the Engineer, air bottle vents shall be brought to false ceiling level and shall terminate with an 8 mm. (0.25" BSP) manual air vent projecting neatly through the ceiling.

On MPHW/HPHW systems the discharge pipe and needle valve shall in all ways be suitable for the pressure and temperature of the system on which they are to be installed and shall be arranged discharge to a safe place.

All exposed air bottles, automatic vents and drip pipes where required shall be properly insulated.

51 DRAINING OF SYSTEM

Drain points shall be provided by the Contractor at all accessible low points of water services installations and also on the branch side of all main isolating valves and cocks whether shown or not on the Drawings.

Drain points shall be fitted with a lock shield drain cock of gunmetal construction manufactured to the requirements of B.S.2879; 1980, type 'A', complete with hose union and removable key. The base of the pocket shall be drilled and tapped to accept a 15 mm. lever operated plug cock of suitable design.

Drain points on MPHW/HPHW systems shall be fitted with a bronze needle valve with plugged outlet.

52 PIPE SLEEVES

In all cases where pipes pass through walls, floors, ceilings and footings, which are not fire rated, the Contractor shall provide sleeves which shall be built in and shall be responsible for ensuring that this is performed correctly. Sleeves shall in no case be used as pipe supports, a free annular space always being provided. Puddle flanges shall be provided on pipework passing through walls and trenches intended to be covered by earth, etc., or where passing through bund walls. Sleeves shall be of pipe cuttings properly reamed, cleaned and trimmed at 90° to bore.

Sleeves in non-load bearing walls, floors ceiling and partitions shall be copper or mild steel to suit the particular pipe materials.

Sleeves shall be provided with an inside diameter of not less than 25 mm. larger than the insulated outside diameter of the pipes. Pipes passing through load bearing walls or footings shall be provided with proprietary 'CSD' type pressure tight bulkhead seals suitable for up to a maximum differential water pressures of 138 Kg/m2 or alternatively, puddle flanged cast iron sleeves shall be provided with an internal diameter 100 mm. larger than the outside of the pipe. The space between the pipe and sleeve shall be sealed with a water tight mastic or silicon rubber compound. Gland plates not less than 6 mm. thick shall be fitted if necessary to withstand water pressures. Details of all sleeving arrangements through liquid - tight walls shall be submitted for approval.

Where pipes pass through fire barriers proved proprietary approved fire rated type mechanical seals shall be provided or alternatively steel sleeves shall be installed with the space between the sleeves and pipework sealed with suitable fire rated material.

External flashing sleeves shall be provided by the Contractor except where indicated otherwise. They shall incorporate an integral flange to which a flashing shield can be clamped or welded. The Contractor shall build the shield into the membrane and fill the space between the sleeves and pipe with waterproof materials or mastic compound.

For pipes, which change direction, oversized sleeves, the size larger than normal shall be fitted to allow for expansion. The space between the pipe enclosed and its sleeve shall be caulked with suitable filling material to be approved by the Engineer

Sleeves shall not protrude from the finished face of` walls. In toilets, kitchens and all other situation where the floor may be swilled, the sleeve shall project 30 mm. above the finished floor level.

53 FLOORPLATES

Where exposed to view, pipes and tubing passing through walls, floors, ceilings, partitions and false ceilings of occupied rooms shall be fitted with a heavy chromium- plated die cast zinc alloy masking plate. Such plates shall be split on the diameter, be a snug fit to the pipe concerned and provided with countersunk holes for set screws.

54 PRESSURE GAUGES, THERMOMETERS AND AUTOMATIC AIR VENTS

A. Pressure gauges

The pressure gauge shall be 100mm dial size made of stainless steel casing filled with glycerin with 6mm dia bottom connection threaded to BS21, scale 0-12 bar. The dial shall be made of aluminum. The bound on tube shall be made of brass.

Accuracy shall be either according to American standard ASME B 40.1 Grade 1B, or European standard EN 837.

Stainless ball valve shall be installed with the pressure gauge size 6mm dia class PN-20.

B. Thermometers

200mm diameter with aluminum finished casing with anti scratch hard powder coat finish. The lens shal be standard clean shatter proof polycarbonate or double strength glass, the scale shall be in ^{o}C,(10 - 50^{o}C) and F,(0 - 120F) and shall be made of aluminum with white finish and black marking. The stem shall be made of aluminum fitted in stainless steel separable socket. Accuracy shall be ±1 of the scale division.

C. Automatic air vent

Shall be fitted with 15mm ball valve. The vent shall be made of brass rated for 10 bar working pressure and 110^{o}C maximum working temperature.

55 VALVES

General:

The brand name of the manufacturer of all valves striners and check valves shall be casted on the body.

1. Domestic Cold and Hot Water Services

A. <u>Isolating Valves ≤ 50mm shall be:-</u>

Threaded bronze or DZR body extended stem ball valve of min PN 20 bar.

B. <u>Isolating Valves ≥ 65m shall be:-</u>

Grooved bronze body butterfly of min PN 20 bar and shall have lever lock / infinitely variable with memory stop for size up to 110mm and gear operated for size larger then 110mm.

C. <u>Non Return Valves ≤ 50mm shall be:-</u>

Threaded bronze or DZR body swing pattern or piston spring , PN 25.

D. Non Return Valves ≥ 65mm shall be:-

Grooved and spring assisted single disk for horizontal and vertical installations, ductile iron body with enemal coating, PN 20 bar.

E. Strainers ≤ 50mm shall be:-

Threaded bronze or DZR body fited with stainless steel perforated strainer element having maximum 0.8mm holes with serewed cap, PN 25 bar.

F. Strainers ≥ 65mm shall be:-
Grooved end bronze body wye type, PN 20 bar

G. Fixted or Variable orifice double regulating valves ≤ 50mm :-
Threaded bronze or DZR body with momery stop lock, PN 20 bar.

H. Variable orifice double regulating valves ≥ 65mm shall be :-
Grooved non ferrous copper alloy body, bonnet, core and spindle, EPDM seat, PN16 bar. From the same manufacturer of ≤ 50mm sizes.

I. Draining Taps ≤ 25mm shall be:-
Bronze angle pattern screw-down draining tap, lockshield type. Male inlet threaed to BS 21 tapper, outlet ribbed to provide integral hose connection. Rated PN 10

2. Compressed Air

A. Isolating Valves ≤50mm shall be:-
Nickel plated brass end entry Ball Valve threaded BS21 taper. Quarter-turn lever operated. Chrome plated Brass Ball. Virgin PTFE seats, blowout proof stem. Gas board tested and certified. Rated PN20.

B. Isolating Valves ≥ 65mm shall be:-
Fully lugged cast iron bodied butterfly valve fitted with Nitrile liner, 316 stainless steel disk and stem. Trigger lever operated with thermal break to prevent transfer of heat to the lever. To fit between PN16 flanges. Maximum temperature 90°C. Rated PN16.

C. Strainers ≤ 50mm shall be:-
Bronze 'Y' type Strainer. Ends threaded to BS 21 taper. Fitted with perforated stainless steel screens with 0.75 mm holes. Machined seats body and cap ends. Screwed-in cap with captive washer. Rated PN20.

D. Strainers ≥ 65mm shall be:-
Cast Iron 'Y' type Strainer. Ends flanged to BS 4504 PN16. Fitted with perforated stainless steel screens with 0.75 mm

holes. Machined seats body and cap ends. Bolted cap with captive washer and drain plug. Rated PN16.

E. Relief Valves ≤ 80mm shall be:-
Bronze Angle Pattern Relief Valve threaded connections to BS 21 fitted with top cover, lever and padlock with 360-rotation facility. Bronze or gunmetal diskwith PTFE insert. Stainless steelsprings.

F. Draining Taps ≤ 50mm shall be:-
Bronze Angle Pattern Screw-down Draining Tap, lockshield type. Male inlet threaded to BS 21 taper, outlet ribbed to provide integral hose connection. Washer EP rubber. Rated PN10.

3 Oil

A. Isolating Valves ≤ 50mm shall be:-
Bronze Gate Valve to BS 5154 Series B threaded to BS 21 taper. Solid wedge disk, non-rising stem, screwed-in bonnet, hand wheel operated. Rated PN20.

B. Isolating Valves ≥ 65mm shall be:-
Cast Iron Gate Valve to BS 5163 flanged BS 4504 PN16. Wedge disk. Bronze seat rings and disk facings. Rated PN16.

C. Non Return Valves ≤ 50mm shall be:-
Bronze Non-return Valve swing type to BS 5154 series 'B' threaded to BS 21 taper. Renewable nitrile rubber disk, free to rotate, and hinge pin mounted. Screwed-in cap. Integral seat. Rated PN25 but limited to 90°C maximum temperature.

D. Non Return Valves ≥ 65mm shall be:-
Cast Iron Non-return Valve swing type to BS 5153 flanged BS 4504 PN16. Bronze faced disk, free to rotate, hinge pin mounted. Bolted cap. Body seat ring bronze. Rated PN16.

E. Strainers ≤ 50mm shall be:-
Bronze 'Y' type Strainer. Ends threaded to BS 21 taper. Fitted with perforated stainless steel screens with 0.75 mm holes. Machined seats body and cap ends. Screwed-in cap with captive washer. Rated PN20

F. Strainers ≥ 65mm shall be:-
Cast Iron 'Y' type Strainer. Ends flanged to BS 4504 PN16. Fitted with perforated stainless steel screens with 0.75 mm holes. Machined seats body and cap ends. Bolted cap with captive washer. Rated PN16.

56 ACOUSTIC STANDARDS FOR MECHANICAL INSTALLATIONS

Vibration Isolation Specifications

1.00 General specifications

A. All mechanical and electrical equipment, piping as noted on the equipment schedule or in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure.

B. All piping located in mechanical equipment rooms, and for a minimum of 50 feet (15.0 m), whichever is greater, from any connection to vibration isolated mechanical or electrical equipment, shall be isolated from the building structure by means of noise and vibration isolation hangers.

C. All isolators shall provide the required static deflection indicated in Appendix II at the end of this section.

D. It is the supplier's responsibility to ensure that all isolators offered to the contract meet the specifications and are suitable for the load, operating and environmental conditions, which prevail.

E. A single manufacturer shall provide all vibration isolation materials specified herein in order to assure single source responsibility for the proper performance of the materials used.

F. The contractor shall submit samples of specified isolation devices upon request to the engineer for approval.

G. The contractor shall have prepared by the isolation materials manufacturer or his representative, and shall submit to the engineer for approval, drawings showing the construction of the isolation devices to be used, including specific selection of the isolators for the equipment to be furnished for this project.

H. The drawing shall include the complete design of supplementary bases; a tabulation of the design data for each isolator. Including spring OD, free operating, and solid heights, and ratio of horizontal to vertical stiffness, and other required data to clearly indicate that the specified isolator types and minimum static deflections are provided by the system submitted.

I. Installation of all vibration isolation materials specified shall be accomplished following the manufacturers written instructions. Installation instruction shall be submitted to the engineer for approval prior to beginning the work.

J. The contractor shall submit a complete set of approved shop drawings of all mechanical and electrical equipment to receive vibration isolation devices to the vibration isolation manufacturer or his representative. The shop drawings furnished shall include operating weights of the equipment to be isolated and the distribution of load at support points.

2.00 Isolator Types and Specifications:

2.01 Floor mounted Equipment

A. Type 1. **(Precompressed fiberglass or neoprene pads)**

1. Pads shall have provisions to be fixed to supported and to supporting structures.

2. Pads shall be resistant to lubricating oil, water, and chemicals likely to be present in the plant room or external area.

3. Pads shall have a minimum rarted static deflection of 0.4 inch (10 mm).

B. Type 2. **(Seismic Isolator Incorporated Within A Steel Housing)**

1. Spring isolators shall be lateral restrained spring isolators, incorporating a single coil spring element, having all of the characteristics of free standing coil spring isolators as previously specified. Springs shall be assembled into a welded steelhousing engineered to limit lateral movement of supported equipment during an earthquake without degrading the vibration isolation capabilities of the spring during normal operating conditions.

2. Vibration isolators shall incorporate a steel angle and plate motion limiting assembly and steel coil spring, designed as a system to accept a force in any lateral direction in excess of the design seismic requirement for the isolator without yield orfailure. Isolator shall limit lateral movement of the equipment to less than 1/4" (6 mm) in any direction. The lateral limit stop shall incorporate a neoprene grommet to prevent the potential for metal-to-metal contact. The vibration isolation element shall include a 1/4" (6 mm) thick ribbed neoprene noise stop pad, positioned outside of the housing anchorage path. The housing shall incorporate drilled holes for attachment to the supporting structure. Similar to model FYS as manufactured by kinetics noise control or approved equal.

2.02 Ceiling suspended Equipment

A. Type 3. **(combination Spring& neoprene Hangers)**

1. Vibration Hangers consisting of unhoused steel springs in series with a molded neoprene insert assembled into a stamped or welded hanger bracket. Hangers shall incorporate a high deflection, color coded spring element and neoprene isolator complete with load plate.

2. Spring shall be epoxy powder coated with 1000 hr salt spray rating per ASTM B-117. Spring shall be color coded or otherwise identified to indicate load capacity. The spring element shall have a minimum lateral stiffness of 1.0 times the rated vertical stiffness.

3. Hanger brackets shall be designed to carry a 500% overload without failure and to allow support rod misalignment through a 30° arc without metal-to-metal contact or other short circuit.

4. The combination isolation hanger assembly with neoprene insert shall be model SRH, as manufactured by kinetics noise control or approved equal.

B. Type 4. **(Fiberglass & neoprene Hangers)**

1. Vibration Hangers consisting of fiberglass or molded neoprene insert assembled into a stamped or welded hanger bracket. Hangers shall be complete with load plate.
2. Hanger brackets shall be designed to carry a 500% overload without failure and to allow support rod misalignment through a 30° arc without metal-to-metal contact or other short circuit.
3. The isolation hanger assembly with fiberglass or neoprene insert shall be model FH or RH, as manufactured by kinetics noise control or approved equal.

Type 5. Seismic Restraint for Ceiling suspended equipment

1. Seismically restrain all suspended equipment above 300LB wt. Use Type J aircraft Cable Restraints for all piping supported by vibration isolation hanger assemblies.
2. Type J cable seismic restraint sizes, quantities, locations, and mounting details shall be as per ASHRAE and or SMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc.) "Seismic Restraint Manual Guidelines for Mechanical Systems", Second Edition

2.03 Inertia Bases

A. Type A. (Concrete Inertia Base)

1. Inertia bases shall be constructed from reinforced concrete and shall be designed for the stressing due to the weight of supported machine. The surface shall be steel float finished or equivalent and leveled to the machine manufacturers requirements. Machinery shall be fixed to the base with ‘grouted-in’ holding down bolts located in reverse tapered caste sockets.

2. Where the inertia base will be supported on spring in shear mountings, the base shall be formed with prefabricated mild steel

continuous edge frame, 13 mm diameter reinforcing bars on nominal 200 mm centers each way. The mountings shall be fixed to brackets, which are welded to the sides of the edge frame.

3. The design of the brackets and mountings shall allow the base to be raised from (or lowered onto) the floor by adjustment of the leveling bolts between mountings and brackets. The design shall also allow the insertion (or removal) of the mountings when the base is resting on the floor.

4. Thickness of the base shall be a minimum of 8% of the longest span between isolators, at least 150 mm. Where inertia bases are used to mount pumps, the bases shall be large enough to support piping elbows.

5. Concrete inertia bases shall have a clearance of 50mm between the housekeeping pad and base.

B. Type B. (Steel Beam Base)

1. Bases shall be structural beam sections, with welded isolator support brackets and percolated and drilled anchor bolts holes, and shall be designed by the isolation materials manufacturer.

2. Beam section shall not be structurally connected to each other. Minimum section depth of each member shall be equal to 8% of the longest span between supporting isolators, or as shown on the drawings or indicated on the project document.

3. Isolator support brackets shall be welded to the structural beams as required to obtain the lowest mountings height for the supported equipment.

4. Steel bases shall have a 25mm clearance between housekeeping pad and base.

3.00 Acoustical Floating Floor System

1. Mechanical equipment bases for (Chillers, Air handling units, pumps, boilers and generators) located on the roof, adjacent to noise sensitive areas or on levels -between floors- shall be acoustically treated by installing propreitary floating floor system.

2. Floating Floor system primarily control airborne sound transmission, they shall not be used in place of vibration isolators and inertia bases.

3. The isolation material supporting the floating slab must be resilient, have permanent dynamic and static properties and safely support both the floating slab and the imposed live load for the life of the building.

4. Isolation material for the floating slab should:

a) Have constant natural frequency in the range of 10-15 Hz.

b) Be resistant to oil, water, acids and fungus, and shall be capable of sustaining a 100% overload without damage or permanent set.

c) Be tested for load Vs deflection and for natural frequency with known aging properties and a history of application in floating floor installations.

d) Be tested in service impact insulation class (IIC) and sound transmission class (STC) by an testing laboratory.

Specifications of the kinetics model Roll-out floating floor System:

1. The noise isolation system shall consist of (2”) 51 mm thick high density pre-compressed molded fiberglass pads separated by low density acoustical fiberglass, the density and spacing of the isolation pads shall be designed by the isolation material manufacturer or his representative on the basis of final evaluation of dead and live loads and in no case shall the uniform load range be less than 1000 kg/sq.m to maintain a constant natural frequency of 15 Hz or lower and uniform deflections of the floating floor. The isolation material shall be shipped to job site in 1.22 m x 15.24 m rolls, 12 mm plywood as the concrete pouring form.

2. The isolation pads shall be spaced at 24 inch centers 61 cm each way and bonded to low density sound absorption material 1 ½ in (38 mm) thick with Noise reduction coefficient of 0.87.

3. Junction plates for maintaining planar alignment of the wood panels shall be 4”x4” 16ga steel attached at four points to the panel system.

4. Perimeter isolation board shall be ¾ “ thick closed cell expanded polyethylene installed around all perimeters, curbs, duct and pipe penetrations.

5. 6-mil (150 micron) Polyethylene sheeting for temporarily waterproofing the isolation system.

6. The floating floor shall consist of minimum 4 inch thick heavy aggregate (2400kg/m3) reinforced concrete.

7. Perimeter sealant (2-component Polysulfide or approved equal)

- Penetrations such Piping, conduit and ductwork penetrations of the floating floors shall be isolated with ¾ inch, closed cell expanded polyethylene.

- Floor drains (if needed) shall consist of two part units designed to be cast into the isolated slab and the structural slab with no rigid connection

between the two members. The drains shall allow for drainage of the air space. The upper member shall contain a grate appropriate to the system.

57 TESTING

The Engineer shall witness all testing and commissioning and shall have access at all reasonable times to such parts of the Contractor's and Suppliers' works as may be necessary for the purpose of inspecting, examining and testing the materials, workmanship and performance.

58 NOTICE PRIOR TO TESTING

The Contractor shall give the Engineer seven days' written notice of his intention to carry out a test and shall have carried out all necessary adjustment prior to commencing the test.

59 TESTING IN SECTIONS

The Contractor shall allow for testing and commissioning the installation in sections as may be required in order to conform with the program. All pipework and ductwork in these sections shall be sealed and tested as specified below, so that the insulation can be applied and the section completed to assist the program.

60 TESTING OF PIPEWORK, WELDS, ETC.

The whole installation shall be hydraulically tested to twice the working pressure of the systems.

Gas pipework shall be tested as above, but utilizing an inert gas.

The pressure shall be maintained for a period of two hours in each case, and due allowance shall be made for attendance by the Engineer during the progress of such tests. The Contractor shall also be responsible for arranging for the water authority to witness this test should they require to do so. Any equipment fitted not suitable for this pressure shall be adequately protected or isolated from the system during the test.

All leaks are to be immediately repaired and the installations retested until the above requirements are obtained.

The Contractor shall allow for such emptying and refilling and maintenance until all leaks have been satisfactorily stopped.

Upon completion of the final hydraulic test on the system, the Contractor shall apply heat and open all valves and charge the calorifiers.

All valves and stopcocks throughout the system shall be adjusted and regulated until all circuits are working under normal conditions and to the satisfaction of the Engineer. Joints found to be faulty under heat are to be completely remade.

All tests are to be carried out before application of the paint or insulation and valve adjustments made with the circulating pumps in operation.

The Contractor shall ensure that before informing the Engineer of the proposed tests, all remedial work has been carried out and that there are no leaks. Failure

to comply with this Clause could result in a charge being made by the Engineer to the Contractor for the abortive visit.

Each welder shall be assigned a reference, which shall be stamped on each weld and when the general hydraulic tests of the completed systems are carried out, each weld shall be lightly hammered during the time that pressure is maintained.

If any leaks occur at welds, the portion of the weld near the leak shall be cut out and rewelded. Such leaks shall not be repaired by caulking or attempted fusion of the surrounding metal. Should a considerable portion of the welded joints made by a particular operator be found to be defective due to faulty workmanship, all such welds shall be cut out and rewelded by another - operator, whose work has proved satisfactory.

During the progress of the Works, inspection will be made by the Engineer to ensure that all burrs and swarf have been removed from cuts and that the cuts have been made square.

The Engineer reserves the right to instruct the Contractor to cut open any sections of the pipework to inspect cuts or to have welded joints laboratory tests.

If the test and inspection should prove that the welds are to the required standard or that all burrs and swarf have been removed, the Client will pay costs incurred by the Contractor in removing testing and replacing the Sections of pipework. If, however, the inspection and test show that the welds or cuts are below the class of workmanship for this class of work, or if they are found to be faulty in any respect, the Contractor shall make good any such faults free of cost to the Client and shall pay all fees incurred by the tests.

If, in the opinion of the Engineer, this result suggests that the standard of workmanship on the whole of the rest of the work is below that required, the Engineer shall be entitled to instruct the Contractor to remove the remainder of the sections in whole or in part and have these sections renewed to conform with this Specification. The Contractor in this case shall have no claim for the costs involved in removing and renewing these sections of the works, whether such Works are found to be faulty or not.

The Engineer's decision shall be final.

61 TEST CERTIFICATES

The Contractor shall at the time of the test present copies of a test certificate for signature by the Engineer and one to be retained by the Contractor.

Insurance company certificates of hydraulic test held at the Manufacturer's work shall be submitted for boilers calorifiers, cylinders.

Manufacturers' certificates, of test at the specified duties held at the manufacturers' works shall be submitted for pumps and fans. No item of equipment shall be delivered to Site before the Engineer has given his approval of the test certificate.

Where no test pressures at factory are given, the test shall be carried out on Site in accordance with the appropriate British Standard (current edition) and subject to the Engineer's approval.

62 TESTING, BALANCING AND COMMISSIONING

1) Scope

Inspect, test, commission and monitor all mechanical services systems and equipment included in this contract together with associated control systems and panels.

Provide all personnel and equipment necessary to carry out the required inspections, tests and commissioning operations including the employment of specialists who would provide and operate testing and monitoring facilities.

2) Related Work Under Mechanical Sections

This section shall relate to all sections included in this contract.

3) Guarantees

Attention is directed to provisions of the General Terms and Conditions and Special Conditions regarding guarantees and warranties for work under this contract.

4) Testing Agency

The contractor shall employ without extra cost to the owner the testing and commissioning and mechanical services to a company approved by the Engineer regularly engaged in providing a testing and commissioning service and who has been in continuous business for not less than 5 years employing fully trained staff having not less than 2 years dedicated experience. A senior experienced commissioning technician shall be responsible for supervising and directing the activities of the commissioning team.

A fully commissioning team shall be provided throughout the full period of commissioning. Changes to the staffing of the commissioning team shall only be made at the request or approval of the Authorized Representative.

The company shall have no vested interest in Project, such as sales of equipment, services etc. and shall not be partly or wholly an owned subsidiary of any vested or interested party, contractor or sub-contractor.

5) Standards

All inspection, testing and commissioning procedures shall conform to the current editions and amendments thereto of the following standards and codes not withstanding current statutory and legal requirements and any other standards and codes which shall apply.

C.I.B.S. Commissioning Codes;

Series B - Boiler Plant
Series C - Controls
Series R - Refrigerating Systems
Series W - Water Distribution systems
BSRIA Application guides and Technical Notes

D.W.142 Specification
British standards and Codes of Practice
I.E.E. Regulations
Local Authority Regulations and Bye-Laws
Health and Safety at Work Act
Government Regulations
Insurance Company(s) Requirements

6) Tests

All tests shall be witnessed and test certificates signed by the Authorized Representative upon satisfactory completion of the tests. One copy of the signed certificate shall be immediately handed to the Authorized Representative.

7) Notice

Clear notice required by the Authorized representative of testing and commissioning activities.

Off site tests	:	14 days
On site tests and inspection	:	2 days
Start up of major plant	:	7 days
Performance tests	:	14 days

8) Submittals

Four (4 No.) copies of all testing and commissioning documentation shall be submitted in bound covers indicated as follows:

A. Certificates:

1. Equipment test certificates
2. System(s) test certificates
3. Welding test certificates if applicable

B. Data Sheets and record manuals:

1. Data sheets of test equipment to be used.
2. Full commissioning and testing data presented on approved record forms for all systems and equipment.

C. Drawings:

1. Equipment detail drawings for equipment.
2. Circuit diagrams for each system with design and actual flow rates and other pertinent data shown.

D. Record forms:

1. Specimen copies of all commissioning record forms shall be submitted for approval of their use on this project.

2. Forms shall be A4 size paper for loose leaf binding, with blanks for listing of the required test ratings and for certification of report.

E) Program of work:

Fully detailed program of work for inspecting, testing and commissioning the works, shall be submitted for approval.

9) Instruments

A.i) All necessary instruments for commissioning and testing as defined in the C.I.B.S.E codes and this specification, shall be included.

ii) All instruments shall have been calibrated within a period of six months and carry a certificate of calibration to that effect. The instruments shall be selected to provide an accuracy compatible with the readings to be taken and the tolerances specified.

iii) The accuracy of the instruments shall be demonstrated to the Authorized Representative and the use thereof shall be subject to his approval.

B. Test instruments shall be available for use to obtain the readings and recorded data required, and shall include but not be limited to the following:-

1. Temperature and humilities:

   a) Electronic thermometers
   b) Mercury in glass thermometers
   c) Aspirated/sling hygrometers

2. Pressures:

   a) Manometer gauges
   b) Magnehelic gauges (diaphragm actuated)
   c) Pressure gauges
   d) Test pressuring equipment

3. Liquid Flow

   a) Manometer gauges across venturies, orifice plates, valves or equipment.
   b) Anuber (Pitot) gauges
   c) Flow meters
   d) Portable pumps

4. Rotational Speeds:

   a) Direct read out electronic digital tachometer
   b) Revolution counter and stop watch

5. Sound Levels:

   a) Sound spectrum analyzer

6. Electrical:

a) Ammeters
b) Voltmeters
c) Multi-meters

7. Vibration:

   a) Accelerometer

8. Recording Instruments:

   a) Hydrothermograph
   b) Multi-point temperature/humidity recorder (plotter)
   c) Digital pressure recorder (plotter)
   d) Sound level recorder

10) General Requirements

A) Definitions:

1. Commissioning: The advancement of the installation from the static completion to full working order calibrated to design requirements, involving the setting-to-work and regulation of the installation (s).

2. Testing: The evaluation of the performance of the commissioned works.

   NB: Preliminary checks on the static installation will carried out by the commissioning Engineers to ensure that it is in a satisfactory and safe condition immediately prior to start up.

B) The Contractor shall apply for, obtain and pay for all permits, tests and inspections that may be required by any of the authorities or agencies having jurisdiction in the performance of the work.

C) Under the adjudication of the Authorized Representative, the Contractor shall coordinate, supervise and carry out all inspection, testing and commissioning activities within an agreed program period.

D) The Contractor shall prepare, submit and agree with the Authorized Representative a detailed program of work defining for each stage: activities, sequence of work, time scales, manpower requirements, start and completion dates and working areas of the building to which access will be required.

E) The Contractor shall allow for carrying out testing and commissioning of the works in phases/stages.

F) The Contractor shall allow for carrying out activities in an occupied building with premium working out of normal office hours in the evening and at weekends.

G) All defects of workmanship, materials, performance design of equipment, maladjustment's or other irregularities, which become apparent during tests, shall be rectified and the tests repeated to the Authorized Representative's satisfaction and at no cost to the contract.

H) Where equipment requires inspection or certification by an insurance company during construction adequate notification shall be given of the date when the equipment will be ready for examination. This shall also apply to on site tests to be witnessed by an insurance company.

I) Before any electrical circuit is energized an "Application for Supply" shall be made. This shall be delivered 24 hours before the supply is required and shall be accompanied by a Test Certificate showing the witnessed values of insulation, resistance and earth fault loop impedance obtained.

J) Before any installation is subjected to site testing or commissioning it shall be thoroughly cleaned both internally and externally.

11) Off Site Tests

When called for by the Authorized Representative or where British Standards or Codes of Practice stipulate tests on items of equipment to demonstrate compliance, these tests shall be carried out at the manufacturer's works or elsewhere, as appropriate. In certain cases, where appropriate, type test certificates will be accepted as follows:

a) Pumps: Type Test Certificates for head, discharge, speed and power input (BS 599)

b) Electric Motors: Type Test Certificates in accordance with BS 5000. For motors of 40 Kw output and above, routine (individual) test certificates in accordance with BS 5000.

c) Starters and control gear: Type Test Certificates BS 587. for control panels as a whole routine (individual) high voltage test in accordance with BS 587.

d) Other electrical equipment, such as air heaters (but excluding thermostatic control equipment): Test Certificates in accordance with BS 6220.

12) On Site Tests

Carry out pressure tests on all ductwork and piping systems in accordance with the requirements of this specification, in Section 2.00 and relevant clauses:

Where fire protection systems are installed they shall be installed in stages to suit the program of work, but upon construction of the first 18 meters in height they shall be capped off at this height and hydrostatically tested this section of the riser shall then be made operative to provide protection to the building this procedure shall be

repeated floor by floor thereafter until the system has been completed after which the entire installation shall be re-tested.

13) Commissioning

Checks and Procedures

A) Prior to any work being commenced, a through inspection of all systems, plant and equipment shall be carried out to check for installation errors, damage, deterioration cleanliness and readiness for testing and commissioning all defects shall be recorded in detail which shall be rectified before work can proceed.

B) When the above procedure has been satisfactorily completed the sequence for each main system shall comprise:

i) Mechanical and electrical engineering safety checks.

ii) Start up and run machines. Pumps shall not be run until system flushing is complete unless used for dynamic flushing.

iii) Regulation calibration or adjustment.

C) The preferred sequence for commissioning the system is:

i) Flushing and pre commissioning cleaning only of water systems.

ii) Commissioning of air distribution systems.

iii) Filling, venting, water treatment, start up and regulation of water systems.

iv) Functional checks on thermal controls associated with water distribution.

v) Commissioning of boiler and calorifier plants and associated controls.

vi) Commissioning of air conditioning and refrigeration plants including associated controls.

vii) Commissioning of controls for air conditioning and ventilation plant.

viii) Commissioning of fire and other safety control circuits including instrumentation, sensing and remote indication.

D) The precise sequence may have to be adjusted for readiness of plant and suitability of weather conditions, subject to the prior approval of the Authorized Representative.

E) i) All water systems, air distribution systems, plant and equipment and control systems shall be fully commissioned in accordance with the C.I.B.S. Commissioning Codes and this Specification.

Where connections to existing services are required, the existing services shall be thoroughly checked and tested also cleaned and repaired where necessary before connecting into new systems.

ii) The tolerance for adjustment of air flow rates shall be generally as stated in C.I.B.S. Commissioning Codes but subject to agreement with the Authorized Representative. Water flow rates shall be adjusted such that volumes to each branch shall be ± 10% of design values and pump volumes shall be + 10%, - 10% of the design value.

iii) The detailed procedure for preliminary checks, setting to work and regulation of the works shall be carried out strictly in accordance with the relevant C.I.B.S. code(s).No deviations to these procedures shall be made without the prior written approval of the Authorized Representative.

iv) Commissioning shall not be considered as complete until the Authorized Representative's approval has been obtained.

v) During the commissioning period of controls arrange for a controls systems engineer to be available on site until the controls systems have been fully commissioned and the witnessing of proving tests have been carried out.

vi) Particular attention shall be paid to the following features:

- Satisfactory operation of any automatic of manually operated sequences to be used in the event of fire.
- Safety in the event of failure and of sudden resumption of electricity supplies.
- Satisfactory operation of safety interlocks designed for the protection of personnel, such as those associated with the high voltage side of equipment and with remote electrically operated plant.

The following item shall checked and/or tested:

- Set desired value of all control devices.
- Satisfactory operation of equipment protection devices.
- The functional correctness of all on/off sequencing interlocks, operations and alternate working selections, automatic or manual change-over of duplicate plant, and modulation ability of all control systems.

vii) The satisfactory operation of all make-up, drain and overflow arrangements shall be checked. Where water treatment is included initial commissioning shall be carried out and then rates of flow, dosing quantities etc. shall be calibrated and set for routine operation. Where controlled blow down is included the controlling device shall be calibrated and set for routine operation.

viii) Damper setting positions shall be scribed on completion of air system balancing.

14) <u>Testing and Commissioning of Controls, MCC's</u>

a. General

All control panels and motor control centers when specified shall be pre-tested at works prior to delivery.

Where it is necessary for the Architect or his Representatives to visit places away from the Works for supervision or inspection in compliance with the Contract, the Contractor shall pay the traveling, subsistence and accommodation expenses of the Architect and his Representation.

Commissioning shall be carried out in accordance with theses requirements together with the C.I.B.Cý.S. Commissioning Code 'C' and relevant I.E.E. Codes and British Standards for testing equipment.

The commissioning shall be completed within the time scales laid down by the Authorized Representative of the Engineer.

The Tender shall include for the provision of all equipment and apparatus necessary for carrying out commissioning and testing on site and to certify that the specified commissioning procedures have been carried out.

b. Static Checks

Checks shall be carried out on all control components to ensure proper location and installation. All anomalies shall be corrected.

Checks shall be carried out to ensure that all control circuit wiring is complete and is safely and correctly installed.

Checks shall be carried out on circuit continuity and earth leakage.

Visual inspection shall be made of all associated motors and equipment to ensure conditions are safe prior to start-up and running.

Checks shall be carried out on rating of all fuses and overloads, and on settings of all safety devices to design requirements.

c. Commissioning

All control systems shall be progressed from the completion of the static installation to full working order, calibrated to design requirements.

d. Testing

All control systems shall be fully tested to check:

1) Functional correctness

2) Modulating ability
3) Sequence operation and interlocks
4) Operation of safety circuits and devices
5) Control ability within design limits

All information relating to controls including set points, control bands limits, pressures, temperatures, etc. The information shall be logged for tabulation and inclusion in the maintenance and operation instructions.

Fault and limit conditions shall be simulated to ensure correct response occurs.

Performance tests shall be carried out to demonstrate that the control systems operate safely and correctly in accordance with the specification and are acceptable to the Authorized Representative of the Engineer.

e. Inspections

Pre-Installation Inspection:

The area and conditions under which the control systems are to be installed shall be examined and any unsatisfactory conditions detrimental to the proper and timely completion of the work shall be corrected. The work shall not proceed until unsatisfactory conditions have been corrected in a manner suitable to the Authorized Representative of the Engineer.

f. Post-Installation Check:

The services of an experienced and competent Engineer/Technician of the manufacturer or supplier of the equipment shall be provided to visit site to inspect, check, adjust if necessary and approve the installations.

The equipment supplier's Engineer/Technician shall be present when equipment is placed in operation.

15) <u>Commissioning records</u>

1. During the commissioning of the installation(s) the results of all checks and measurements taken for all systems and equipment shall be tabulated and recorded on approved record sheets. System and equipment design data shall also be tabulated on the same from for comparison.

2. Written records are to be maintained, throughout the commissioning and testing, of all measurements made, and all settings and adjustment imposed on the plant. This shall include precise details of all thermal controls, including sensitivities, proportional bands, integral times and delay times. They shall be submitted to the Authorized Representative for approval, as they are prepared at each stage of the works.

3. All data shall be collated and produced as a single commissioning and testing record manual, enclosed in a loose

leaf ringed plastic covered binder. On completion, a draft copy of the manual shall be submitted for approval prior to the production of the three final copies.

4. The information recorded shall include but not necessarily be limited to the following, and shall also include all plant data including name of manufacturer, type of equipment, model number, system reference, etc.:

•Pumping equipment

Water flow rate	L/S
Static pressure	m/water
Suction pressure	m/water
Discharge pressure	m/water
Pump speed	R.P.M.
Pump power (absorbed)/phase	Amp/Amp/Amp
Motor speed	R.P.M
Motor power (name plate) FLA	Amp.

• Heat exchangers:

Primary water flow	L/S
Primary water on/off temps.	°C
Primary water pressure drop	m/water
Secondary water flow	L/S
Secondary water on/off temps.	°C.
Secondary water pressure drop	m/water
Duty	Watt

• Water systems (piping & Control Valves)

Flow through main and sub-circuits	L/S
Flow through control valves	L/S
Pressure drop through control valves	m/water
Pressure drop across strainers	m/water
Supply temperature	°C.
Return temperature (after coil)	°C
Return temperature (after mixing valve)	°C.

• Motor data:

Name plate power (FLA)	Amp
Voltage	V
Motor absorbed power/phase	Amp/Amp/Amp
Cycles	
Starting current	Amp

• Controls:

Set values of all control devices
Control bands on all control devices
Set values of all protection devices.

• Steam boilers and calorifiers

Duty	KW
Steam Output	kgs/hr
Water "on" temp.(calorifiers)	°C
Water "off" temp (calorifiers)	°C
Water pressure drop (calorifiers)	m/water

Control thermostat setting	°C
Safety thermostat setting	°C

- Expansion Tanks

H.P Operation	bar
H.P Switch setting	bar
L.P Operation	bar
L.P Switch Setting	bar
P.R.V. Switch Setting	bar
P.R.V. Setting	bar
Level in break tank	mm.
Float switch operation	mm.
Float switch setting	mm.

- Terminal Units

Damper motor operation
Interlock with hood and extract fan

- Cold rooms and freezer rooms

Refrigerant Type	
Room temperature	°C
Ambient temperature on condenser	°C
Compressor suction pressure	bar
Compressor condensing pressure	bar
Sight glass indicator (full/partial)	
Compressor motor absorbed power	Amp/Amp/Amp
Compressor motor power rating FLA	Amps
Compressor motor applied voltage	V
Compressor motor rated voltage	V

16) Performance Tests

A. Carry out and supervise the operation of the commissioned installations for such a period as necessary to satisfactorily evaluate and demonstrate to the authorized representative, the performance of the installations by use of measuring and recording instruments that the installations function correctly and maintain the required conditions within the specified limits.

B. Provide artificial loads as required for the purpose of simulating internal and external loads.

C. During the trial period, plant and building conditions shall be checked and monitored, all necessary adjustments made and recorded on final report sheets.

D. During the trial period, provide training to the clients nominated staff in the operation of the plant.

E. No test or trial shall be carried out while conditions are abnormal.

G. Provide the Authorized Representative with 14 days clear notice of roposed commencement date of performance tests.

17) Equipment Cards

Install at each piece of equipment a "Check out" card showing all significant operating temperatures, pressures, amperes, voltages, power consumption flow rates, resistance, etc. Check out cards shall be standard 125 mm. x 200 mm. stiff index card enclosed in a clear film card folder, securely attached to equipment, or wall in immediate areas.

18) MANUFACTURER'S NAMEPLATES

Nameplates: Each item of mechanical equipment and plant shall have the manufacturer's name or trademark on a corrosion-resistant metal nameplate, securely affixed in a conspicuous place. The manufacturer's name or trademark may be cast integrally, 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.

19) Documentation

The whole of the information requested in this specification including:-

- Plant data
- Test certificates
- Commissioning records
- Performance test reports
- Circuit diagrams

shall be collated, indexed and assembled into manuals having vinyl covered loose leaf ring binder covers with the project title and then words "Commissioning Data" permanently printed on the front cover. The commissioning companies name, address and telephone number shall be printed on the inside of the front cover.

Four sets of the above manuals shall be handed to the Authorized Representative within ten weeks of the completion of commissioning and performance tests. The installation shall not be accepted until the final approved manuals have been handed over.

APPENDIX I
MINIMUM THICKNESS OF INSULATION

Size of Pipe in mm			Minimum Thickness (mm) of Insulation		
Steel	Copper	All Cold Water System, Cold Feeds & Open Vents	L.T.H.W. D.H.W.S. Systems	M.T.H.W. Systems Condense	H.T.H.W Systems & Steam
15	15		25	32	50

20	22		25	50	50
25	28		25	50	50
32	35		25	50	50
40	42		25	50	50
50	54		25	50	50
65	67		25	50	50
80	76		25	50	50
100	108		50	50	75
125	133		50	63	75
150	159		50	63	100
200	-		50	63	100
250	-		63	63	100
300	-		63	75	100
350	-				
External and in plantrooms (all sizes)		50	50	50	100

Declared Thermal Conductivity (w/m per °C)	Up to 0.06	Up to 0.040	Up to 0.040	Up to 0.040	Up to 0.055

APPENDIX II

EQUIPMENT VIBRATION ISOLATOR SCHEDULE

Equipment	Location	Type Description	Isolator minimum static deflection (mm)
Pumps Above to 3 kw	All	Type 2 / A	25
Air handling units	Floor mounted	Type 2	25
Air handling units	Suspended	Types 3 &5	25
Fan Coil units	Suspended	Type 4	25
Axial or centrifugal fans	Suspended	Types 3 &5	25
Axial or centrifugal fans	Floor mounted	Type 2	25
Fire – tube & steam boilers	All	Type 2	25
Engine-driven generators	All	Type 2	25
Air compressors	All	Type 2	25
Condensing units	All	Type 2	25

END OF SECTION 15020

SECTION 15082

PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes hot water piping insulation and cold water piping insulation inside the building , on the building roof and car parks .
   1. Insulation Materials:
      Flexible elastomeric.
   2. Adhesives.
   3. Mastics.
   4. Factory-applied jackets.
   5. Tapes

B. Insulation systems shall include:
   1. Piping insulation, jacketing and accessories.
   2. Equipment insulation and jacketing and coating and accessories.
   3. Ductwork insulation and jacketing lining and accessories.
   4. Firestopping.
   5. Accessories.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Samples: For each type of duct, equipment and pipe insulation and jacket indicated. Identify each Sample, describing product and intended use.

C. Qualification Data: For qualified Installer.

D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

C. Mockups: Before installing insulation, build mockups for each type of pipe, duct and equipment insulation and finish to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by the Engineer. Use materials indicated for the completed Work.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 15 Section "Hangers and Supports."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

PIPE INSULATION

A. Provide insulation as indicated and specified.

B. The following piping systems shall be insulated:
Domestic hot water systems inside and outside the buildings.
Domestic cold water systems on the roof exposed to the sun and in the
The car parks .

C. Pipe Insulation :-

1. This type of insulation shall apply to domestic hot water pipes supply and return , domestic cold water pipes on the roof exposed to the sun and on the car parks and shall be completely and fully wrapped with plastic tape.
2. Pipe insulation shall be flexible elastomeric, closed cell expanded rubber 12mm thick, density 65-80kg/m^3. Insulation shall be chemical and oil resistant, self extinguishing, and shall withstand a temperature ranging from 40°C to 120°C, with UV protective coating as recommended by insulation manufacture

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
   1. Verify that systems and equipment to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. For above ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   4. Manholes.
   5. Handholes.
   6. Cleanouts.

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent

pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

3.5 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
   1. vapor-barrier mastic and flashing sealant.

3.6 FINISHES

A. Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 9 painting Sections.
   1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
      a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by the Engineer. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.7 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

END OF SECTION 15082

SECTION 15126

METERS AND GAGES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes meters and gages used in mechanical systems:
   1. Thermometers.
   2. Pressure Gages.
   3. Test plugs.

1.3 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated; include performance curves.

B. Shop Drawings: Schedule for meters, thermometers and gages indicating manufacturer's number, scale range, and location for each.

C. Product Certificates: For each type of meters, thermometer and gage, signed by product manufacturer.

1.5 QUALITY ASSURANCE

A. Materials and work shall conform to the latest edition of specifications and industry standards and to applicable codes and requirements of local authorities having jurisdiction, whichever is more stringent.

B. Certification: Provide meters whose accuracies, under specified operating conditions, are certified by manufacturer.

PART 2 - PRODUCTS

2.1 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

A. Case: Brass 9 inches (229 mm) long.

B. Tube: Red or blue reading, mercury filled, with magnifying lens.

C. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

D. Window: Glass.

E. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

F. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.

G. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.2 DIRECT-MOUNTING, VAPOR-ACTUATED DIAL THERMOMETERS

A. Case: Liquid-filled type, cast aluminum 4-1/2-inch (114-mm) diameter.

B. Element: Bourdon tube or other type of pressure element.

C. Movement: Mechanical, connecting element and pointer.

D. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.

E. Pointer: Red metal.

F. Window: Glass.

G. Ring: Brass.

H. Connector: Rigid, bottom type.

I. Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem for thermowell installation and of length to suit installation.

J. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.3 REMOTE-MOUNTING, VAPOR-ACTUATED DIAL THERMOMETERS

A. Case: Dry type, drawn steel or cast aluminum, 4-1/2-inch (114-mm) diameter with holes for panel mounting.

B. Element: Bourdon tube or other type of pressure element.

C. Movement: Mechanical, connecting element and pointer.

D. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.

E. Pointer: Red metal.

F. Window: Glass.

G. Ring: Brass.

H. Connector: Bottom union type.

I. Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem for thermowell installation and of length to suit installation.

J. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.4 BIMETALLIC-ACTUATED DIAL THERMOMETERS

A. Description: Direct-mounting, bimetallic-actuated dial thermometers complying with ASME B40.3.

B. Case: Liquid-filled type, stainless steel with 3-inch (76-mm) diameter.

C. Element: Bimetal coil.

D. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.

E. Pointer: Red metal.

F. Window: Glass.

G. Ring: Stainless steel.

H. Connector: Adjustable angle type.

I. Stem: Metal, for thermowell installation and of length to suit installation.

J. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.5 THERMOMETER WELLS

A. Description: Fitting with protective well for installation in threaded pipe fitting to hold test thermometer.
   1. Material: Brass, for use in copper piping.
   2. Material: Stainless steel, for use in steel piping.
   3. Extension-Neck Length: Nominal thickness of 50 mm, but not less than thickness of insulation. Omit extension neck for wells for piping not insulated.
   4. Insertion Length: To extend to one-third of diameter of pipe.
   5. Cap: Threaded, with chain permanently fastened to socket.
   6. Heat-Transfer Fluid: Oil or graphite.

2.6 SEPARABLE SOCKETS

A. Description: Fitting with protective socket for installation in threaded pipe fitting to hold fixed thermometer stem.
   1. Material: Brass, for use in copper piping.
   2. Material: Stainless steel, for use in steel piping.
   3. Extension-Neck Length: Nominal thickness of 50 mm, but not less than thickness of insulation. Omit extension neck for sockets for piping not insulated.
   4. Insertion Length: To extend to one-third of diameter of pipe.
   5. Cap: Threaded, with chain permanently fastened to socket.
   6. Heat-Transfer Fluid: Oil or graphite.

2.7 PRESSURE GAGES

A. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type.
   1. Case: Liquid-filled type, drawn steel or cast aluminum, 4-1/2-inch (114-mm) diameter.
   2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
   3. Pressure Connection: Brass, NPS 1/4 (DN 8), bottom-outlet type unless back-outlet type is indicated.
   4. Movement: Mechanical, with link to pressure element and connection to pointer.
   5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
   6. Pointer: Red metal.
   7. Window: Glass.
   8. Ring: Brass.
   9. Accuracy: Grade A scale.
   10. Vacuum-PressureRange: 30-in. Hg of vacuum to 15 psig of pressure (100 kPa of vacuum to 103 kPa of pressure).
   11. Range for Fluids under Pressure: Two times operating pressure.

B. Remote-Mounting, Dial-Type Pressure Gages: indicating-dial type.
   1. Case: Dry type, drawn steel or cast aluminum, 4-1/2-inch (114-mm) diameter with holes for panel mounting.
   2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
   3. Pressure Connection: Brass, NPS 1/4 (DN 8), bottom-outlet type unless back-outlet type is indicated.
   4. Movement: Mechanical, with link to pressure element and connection to pointer.
   5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
   6. Pointer: Red metal.
   7. Window: Glass.
   8. Ring: Brass.
   9. Accuracy: Grade A scale.
   10. Vacuum-PressureRange: 30-in. Hg of vacuum to 15 psig of pressure (100 kPa of vacuum to 103 kPa of pressure).
   11. Range for Fluids under Pressure: Two times operating pressure.

C. Pressure-Gage Fittings:
   1. Valves: NPS 1/4 (DN 8) brass or stainless-steel needle type.
   2. Snubbers: NPS 1/4 (DN 8) brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.8 TEST PLUGS

A. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

B. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).

C. Core Inserts: One or two self-sealing rubber valves.

D. Test Kit: Furnish one test kit(s) containing one pressure gage and adaptor, two thermometer(s), and carrying case. Pressure gage, adapter probes, and

thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

A. Install thermometers in the outlet of each domestic, hot-water storage tank.

B. Install case-type, actuated dial thermometers at suction and discharge of each pump.

3.2 GAGE APPLICATIONS

A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.

B. Install liquid-filled-case-type pressure gages at suction and discharge of each pump.

3.3 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

B. Install remote-mounting dial thermometers on panel, with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.

C. Install thermowells with socket extending a minimum of 2 inches (51 mm) into fluid and in vertical position in piping tees where thermometers are indicated.

D. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.

E. Install remote-mounting pressure gages on panel.

F. Install needle-valve and snubber fitting in piping for each pressure gage.

G. Install test plugs in tees in piping.

H. Install permanent indicators on walls or brackets in accessible and readable positions.

I. Install connection fittings for attachment to portable indicators in accessible locations.

J. Install thermometers and gages adjacent to machines and equipment to allow service and maintenance for thermometers, gages, machines, and equipment.

K. Adjust faces of thermometers and gages to proper angle for best visibility.

END OF SECTION 15126

SECTION 15130

PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION

A. The extent of pump work is indicated on drawings and in schedules, and by requirements of this section. Belt-driven pumps are not to be used, unless a direct drive unit cannot meet the design parameters.

B. The types of pumps specified in this section include the following:
1- Submersible Waste Water and Rain Water pumps.

1.02 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of all pumps types, sizes and capacities required, whose products have been in satisfactory use in similar service for not less than 10 years

B. Compliance: Pump and motor shall comply with the requirements of EN and IEC standards.

C. All pumping units shall be designed and built for twenty-four hour continuous service at any and all points within the specified range of operation, without overheating, without cavitation, without excessive vibration or strain and requiring only that degree of maintenance generally accepted as normal for the specific type of pump required. Pumps not meeting the specified requirements shall be rejected.

D. The Agent or Authorized Dealer should be representing directly the manufacturer, a formal letter should be issued in the name of the Agent or Authorized Dealer directly from the manufacturer.

E. The Agent or Authorized Dealer should be registered in Jordan for not less than 5 years, and should have experience in selling, installing and maintaining pumps systems in Jordan.

F. Guarantee: **The pump set shall be the latest and newest model and latest technology for the manufacturer products** and shall include a (2) two years full guarantee, full warranty and full preventive maintenance on all parts and labor after acceptance by the Engineer and the owner including regular visits two times a year and upon request (cost of spare parts ,labor and regular visits and upon request deemed to be included in the contractor's cost for the two years after acceptance) .

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's pump specifications installation and operating instructions, and current accurate pump characteristic performance curves with selection points clearly indicated. (Total Dynamic Head, Pump Efficiency, Brake Horse Power expressed in KW, Net Positive Suction Head, Power Input).

B. Shop Drawings:

1. Submit drawings and information necessary for final design of foundations, structural supports, connected piping and valves electrical connections, starting and protective equipment and auxiliary equipment.

2. Submit for all pumping units, a dimensional drawing of the complete pump, drive and all associated equipment furnished. Such drawing or drawings shall show plan, elevation and any other view or section requested.
3. For all pumping units a scaled cross-sectional drawing of the assembled pump showing full details and materials of construction shall be submitted for approval.

C. Maintenance Data: Submit maintenance data and spare parts lists for each type of pump. Include this data in installation and operating instructions manual.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver and store pump products in factory-wrapped packages, which properly protect pumps against weather, dirt and damage.

B. Handle pumps carefully to avoid damage to motors, components, enclosures and finish.

PART 2 - PRODUCTS

2.01 GENERAL

A. General: Provide tested pumps, thoroughly cleaned, and painted with one coat of machinery enamel prior to shipment. Type, size, and capacity of each pump is listed in pump schedule. **The Contractor shall calculate the head for all pumps based on his actual layouts as approved shop drawings and shall submit calculations for Engineer's approval**. Provide pumps of same type by same manufacturer, where possible. Select pumps to operate at an efficiency of 70% or higher, where possible.

B. Pumps shall be manufactured and installed in such a way that pump suction is always flooded.

C. Pump system shall have duplex or triplex pumps to provide 100% capacity with one pump out of service.

D. Pumps shall be designed to permit disassembly without piping disconnections.

2.02 Submersible Waste Water and Rain Water pumps (SUBP-1) & (SUBP-2):

A. pump set shall be of two pumps, one duty and one standby to the sizes shown on the project drawings and schedules.

B. pumps shall be suitable for dry pit installation and with cooling jacket for discharge size din 80mm and above. Each pump shall be complete with non-return valve and isolating ball valve on the pump discharge. These valves shall be fitted above the normal highest liquid level and in a location accessible from the surface as shown in drawings.

C. Pumps shall be supplied complete with control panel for automatic operation and auto changeover of duty/standby pumps. Control panel shall have visual/audible alarm.

D. Pump components shall be manufactured of the following materials: -
Motor : Explosion proof 3 - phase or single phase, insulation class F, protection type IP68.
Pump housing : Grade 304 stainless steel or cast iron to BS1452 grade 20.
Impeller : Grade 304 stainless steel or cast iron to EnGJL 250 .
Pump sleeve : Grade 316 stainless steel.
Shaft : Grade 304 stainless steel.
Bearing : Heavy-duty pre-lubricated ball bearings.
O-rings : Neoprene rubber.

E. Local isolators shall be located adjacent to the sump for isolation of units during maintenance.

F. Discharge pipe within sump between pump and valves shall be heavy-duty reinforced rubber hose.
G. Pumps shall be furnished with stainless steel pulling chains.
H. Pump shall be provided with a built in grinder or Vortex Impeller with new no clogging .
I. Pumps shall be provided with a duck foot elbow and cast iron or ductile guide rail.
J. The control panel shall be constructed of 1.5 mm thickness sheet steel and IP65 protection.
K. The control panel shall include all features and components shown in the drawings.
L. The sequence of operation described in the drawings shall be tested at the completion of the works.

PART 3 - EXECUTION

3.01 INSTALLATION OF PUMPS

A. General:

1. Install pumps where indicated, in accordance with manufacturer's published installation instructions, with recommended clearance provided for service and maintenance.

2. Ensure that pump units are wired properly, with rotation in correct direction, and that pump and motor grounding have been provided. Refer to Division 16 for power wiring.

1. The pumps to be checked for correct rotation and meet the specified details regarding performance duty.

2. Install gate or butterfly valve and strainer on suction side of pump and a pressure gauge piped to read both suction and discharge. On the discharge side install silent check valve and double regulating valve. Flexible connections shall be installed on both sides of pump. Inlet piping shall be arranged to prevent the possibility of cavitations.

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

4. 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 base mounted pumps, install supports under elbows on pump suction and discharge line sizes 100 mm and over.

5. Install pumps on vibration isolators. Refer to Section 15070.

6. Install flexible connectors at or near pumps on suction and discharge pipes.

B. Base-Mounted Pumps: Unless otherwise indicated, install on minimum of 100 mm high concrete base equal or greater than 3 times total weight of pump and motor, with anchor bolts poured in place. Set and level pump, grout under pump base with non-shrink grout.

1. Pump and motor must be checked for alignment after the pump base has been installed and grouted in place. There shall be no strain transmitted to the pump. The concrete support shall be as recommended by the manufacturer and detailed on drawings. Provide cast supports in the lower half for securely bolting the pump body to the base plate. Suitable lifting lugs shall be provided to lift each part individually. Suitable instruments drain and vent connections, and other accessories shall be provided.

2. Anchor Bolts - Pump Bolts: Anchor bolts and nuts shall be steel and shall be furnished by pump manufacturer. Acceptable special washer and nuts to be furnished on the lower ends of the bolts unless pockets provided for access to the nuts. Expansion bolts shall not be used for anchoring pumping equipment.

3. Pump Connections: Pumps shall be provided with flanged inlets and outlets that are compatible with the pipeline to which it is connected.

4. Suction and Discharge Elbows: Provide each pump with a suction elbow enclosed by the base or foundation. A reducing elbow shall be provided where suction pipe is larger than the suction flange. The suction and discharge connections shall be of the same pressure ratings as the adjoining pipes and fittings and shall be of such sizes that the velocity of each opening shall not exceed 3.6 m/sec.

C. In-line Pumps: Support from piping system, and locate for access to oil cups, service, and maintenance.

END OF SECTION 15130

SECTION 15150

SANITARY WASTE STORM AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following for sanitary drainage and vent piping, and storm drainage piping inside the building and to locations indicated:
   1. Pipe, tube, and fittings.
   2. Special pipe fittings.

1.3 DEFINITIONS

A. Sewerage Piping: Building sewer piping outside building that conveys sanitary sewage from building.

B. Drainage Piping: Building sewer piping outside building that conveys storm drainage from building.

C. Service Entrance Piping: Drainage piping at entry into building between outside building sewer piping and inside drainage piping.

D. Drainage and Vent Piping: Piping inside building that conveys waste water and vapors from fixtures and equipment throughout the building.

E. Force-Main Piping: Drainage piping, under pressure.

F. The following are industry abbreviations for plastic and other piping materials:
   1. EPDM: Ethylene-propylene-diene polymer, rubber.
   2. NBR: Acrylonitrile-butadiene rubber.
   3. PVC: Polyvinyl chloride.
   4. PP: Polypropylene.

1.4 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with the following minimum working-pressure ratings, unless otherwise indicated:
   1. Soil, Waste, and Vent Systems: 30 kPa (10-foot head of water).
   2. Storm Drainage Systems: 30 kPa (10-foot head of water).
   3. Sewage, Force-Main Piping Systems: 690 kPa (100 psig).

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events, ASCE 7.

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Shop Drawings:
   1. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.
   2. Solvent Drainage System: Include plans, elevations, sections, and details.

C. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. The plumbing pipework shall comply fully with the latest relevant British Standards or DIN Standards as specified .

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

B. The above ground drainage installations shall mean all pipe work inside buildings and located as follows.
   a. Above floor slab.
   b. Under tiles.
   c. Embedded in walls.
   d. At high level or low level exposed or concealed.
   e. All vertical pipes (risers).
   f- All drainage pipe work installed belowground slab

C. The below ground drainage installation shall mean all drainage pipe work installed between manholes and buried underground either outside building or in basement level.

D. POLYPROPYLENE PIPES AND FITTINGS (PP) (for above ground drainage installations):
   1. Silent PP mineral reinforced polypropylene pipes and fittings with sound insulation layer, high molecular density not less than 1.6 g/cm^3, to DIN 4102-B2 and DIN 4109, 95C water temperature,self extinguishing, fire and chemical resistant.
   2. Joints of pipes and fittings shall be made with push fit joints with EPDM or SBR rubber ring.
   3. Installation, supporting and jointing of PP pipes and fittings shall be as per manufacturer recommendations and instructions.
   4. Direct embedded pipes in concrete walls shall be as per manufacturer recommendations and instructions.
   5. Pipe ends must be square, free from burrs, smooth and clean before joining is carried out.

6. The pipes and fittings should be produced according to EN 1451, DIN 4109, DIN 14366 and DIN 4102.
7. Sound level as per DIN 4109 shall not be more than 20 DB at flow rate of 4 l/s, behind a wall of 220 kg/m2. Certificates shall be provided.
8. To maintain the fire resistance of Fire walls and floors when they are penetrated by the soil system, either a fire collar needs to be installed.
9. The pipe system needs to be resistant against continuous temperatures of 90°C and peak temperatures of 100°C.
10. Expansion compensator socket needs to be installed, as recommended by the manufacturer.
11. Use full encircling brackets with rubber inserts.
12. Each pipe section between floors must be secured by a fixed bracket.
13. Every horizontally installed pipe should always be fixed with one fixed bracket.
14. Installation to be according to the manufacturer installation instructions
15. Date of manufacturing for pipe and fittings shall not be more than two years of date of the submittal.
16. Pipe thickness shall be not less than:
    Diam 50: thickness 4.0mm
    Diam. 75: thickness 4.5mm
    Diam. 110: thickness 5.3mm
    Diam.160: thickness 5.3mm
    Diam.200: thickness 6.2mm

E. UPVC PIPES AND FITTINGS
1. UPVC pipes and fittings manufactured to (BS EN 1401.1:1998) standards suitable for Below ground application and to (BS EN 1329.1:1998) standards suitable for above ground application.
2. All joints for all sizes for pipes and fittings shall be push fit type.
3. All pipe and fittings shall be from one manufacturer .

F. UPVC PRESSURE PIPES AND FITTINGS
1. UPVC pressure pipes and fittings manufactured to DIN standards suitable for pressure (16 bar) PN16.
2. All UPVC pipework shall be ultra violet resisting.
3. UPVC socket or threaded fittings of the same rating as pipes.

2.4 SPECIAL PIPE FITTINGS

A. Flexible, Nonpressure Pipe Couplings: elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Shielded Nonpressure Pipe Couplings: elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

C. Rigid, Unshielded, Nonpressure Pipe Couplings: sleeve-type reducing- or transition-type mechanical coupling molded from TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Flexible Ball Joints: Ductile-iron fitting with combination of flanged and mechanical-joint ends. Include gasketed ball-joint section and ductile-iron gland, rubber gasket, and steel bolts.

E. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections. Select and assemble components for expansion indicated. Include ductile-iron glands, rubber gaskets, and steel bolts.

F. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends. Include ductile-iron glands, rubber gaskets, and steel bolts.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

3.2 PIPING INSTALLATION

A. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

B. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.

C. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight.

D. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.

E. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

J. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

K. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
   1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 (DN 75) and smaller;1 percent downward in direction of flow for piping NPS 4 (DN 110) and larger.
   2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.

3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

L. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

M. Do not enclose, cover, or put piping into operation until it is inspected and approved by the Engineer

3.3 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 15 Section "Valves."

B. Shutoff Valves: Install shutoff valve on each sewage pump discharge.
1. Install gate or full-port ball valve for piping NPS 2 (DN 50) and smaller.
2. Install gate valve for piping NPS 2-1/2 (DN 65) and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to sewage backflow.
1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
2. Floor Drains: Drain outlet backwater valves, unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.
4. Backwater valve are specified in Division 15 Section "Plumbing Specialties."

3.4 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 15 Section "Hangers and Supports."

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:
1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but notsmaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but notsmaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but notsmaller than required by plumbing code.
4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main or sanitary manhole.
2. Sewage Pumps: To sewage pump discharge.

3.6 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 15150

SECTION 15155

DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following drainage piping specialties:
1. Floor Drains (FD)
2. Parking Floor Drains (PD)
3. Area Drain (AD)
4. Trench Grate & Frame (TD)
5. Cleanouts (FCO)
6. Roof Vent Cowls (RVC)
7. Balcony drain (BD)
8. Roof Water Drain(RWD)
9. Cleanout – Type (H.F.C.O)
10. Wall Cleanout – Type (WCO)
11. Manhole
12. Gully Trap
13. Camlock Fittings set

B. Related Sections include the following:
1. Division 15 Section "Plumbing Fixtures" for hair interceptors.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene.

D. PE: Polyethylene.

E. PP: Polypropylene.

F. PVC: Polyvinyl chloride.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:

1. Grease interceptors.
2. Grease removal devices.
3. Oil interceptors.

B. Shop Drawings: Show fabrication and installation details.
1. Wiring Diagrams: Power, signal, and control wiring.
2. Retain paragraph and subparagraphs below if required by seismic criteria applicable to Project. Coordinate with Division 15 Section "Mechanical Vibration and Seismic Controls."
3. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
4. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency..

PART 2 - PRODUCTS

2.1 PLUMBING ITEMS

A. Floor Drain (FD)

1. Floor drain type 75 mm: PPR of same pipe material , with minimum 5 cm trap seal, one outlet and multiple inlets complete with Stainless Steel cover and plate size 15cmx15cm which shall be also equipped with stainless steel screw.

B. Parking Floor Drains(PD)

Supply and install where shown on drawings extra-heavy duty floor drains where shown on the Drawings in Parking areas.

Each drain shall have square heavy-duty metallic compound material resistant grating square 30cmx30cm with lockable strainer (12.5 tons point load rating), but without a trap.

C. Area Drain (AD)

Each area drain shall be bottom outlet no trap type. Each drain shall have square heavy-duty metallic compound material, corrosion resistant grating square 30cmx30cm with lockable strainer (12.5 tons point load rating) with strainer at outlet, but without a trap.

D. Gutter Trench Grate (TD):

Supply and install wherever shown on drawings gutter and grates and frames as hereinafter specified.

Gutter (trench) and Grate (Slotted grille) shall be made of heavy rectangular, sectional bar pattern, of cast iron suitable for heavy traffic with width , depth and length as shown on the drawings , the body enclosure shall be made of heavy duty plastic .

E. Cleanouts (FCO)

Supply and install cleanouts wherever shown on the Drawings and of sizes as detailed on the Drawings.

Each cleanout shall be of the same material and dimensions as the pipe to be cleaned, and shall be placed at ceiling level, in walls, or slabs, as need be, for ease of operation.

Ceiling pipe cleanouts on PVC or PP-R pipes shall be shall have access plug and screw caps of the same material.

Floor clean outs shall be covered with stainless steel access cover (150x150mm), screwed odor-tight with a backwater-proof seal up to 0.5 bar

F. Roof Vent Cowl (RVC)

Roof vent cowl shall be provided for all vent pipes as shown on the drawings. Roof vent cowl shall be made of the same material of the pipe.

G . Balcony Drain(BD)

Shall be made of ABS. with inserted cover from synthetic material and outlet size 75mm.

H. Roof water drain (RWD)
Abs or plastic ,**side wall roof drain** with sealing flange for connection to polymer pipe outlet size 110mm, all screws shall be made of stainless steel .

I. Cleanout – Type (H.F.C.O)

Heavy Duty adjustable floor cleanout, with Dura-coated cast iron body with gas and water tight ABS tapered thread plug, and round scoriated secured top and Dura-coated cast iron cover adjustable to finished floor as to Zurn Z1400 or approved equal.

The FCO is for use in conjunction with the standard pipe fittings forming cleanout branch at each change in direction, greater than 45° or near the foot of every vertical stack and on long horizontal pipe runs at 12m intervals.

The clean out shall be installed such that it opens opposite to the direction of the flow of the drainage system or at right angles thereto.

J. Wall Cleanout – Type (WCO)

Recesed NPT threaded plug for use in conjunction with the standard pipe fitting forming cleanout branch at each change in direction, greater than 45° or near the

foot of every vertical stack and on long horizontal pipe runs at 15m intervals. The clean out shall be covered with Stainless steel polished top and frame access cover.

The clean out shall be installed such that it opens opposite to the direction of the flow of the drainage system or at right angles thereto.

K. MANHOLES

Cement and Concrete

a) Cement

All cement used in all classes of concrete for drainage and sewerage works, whether above or below ground level, shall be sulphate resistant cement, complying with BS 4027

b) Granolithic Concrete

Granolithic Concrete shall be mixed using one part by weight of Portland cement to two parts of clean granite chippings graded as Table 1 of BS 882, to one part of sharp siliceous sand graded as Table 2 and clear water sufficient to form a stiff but workable mix and provide a dense concrete.

c) Cement Mortar

Cement mortar shall consist of sulphate-resisting cement and sand gauged by volume in suitable boxes in the proportions as proposed by BS standards

Unless otherwise specified cement mortar shall be SRC Class No.1.

The ingredients of the mortar shall be mixed in an approved mechanical mixer or shall be mixed together dry on a clean wooden stage until the mix is homogeneous in colour. Water shall then be added through a rose in sufficient quantity to give no more than stiff workability. The Whole shall then be turned until perfectly mixed.

Mortar shall be used within 30 minutes of mixing and shall not be remixed or worked up again after it has stiffened. Any mortar that has commenced to set shall be removed from the works.

Concrete Classification

CONCRETE GRADE	CHARACTERISTIC STRENGTH N/mm^2	APPLICATION
SRC 30	30	Precast Concrete
SRC 25	25	Normal reinforced concrete, blinding thrust blocks
SRC 25	25	Mass concrete hard standings
SRC 20	20	Mass concrete, pipeline protection and surrounds protection to tanking and hollowing block infill.
MIX PROPORTION FOR CEMENT MORTAR		
PROPORTION BY VOLUME FOR CEMENT		
Cement	Sulphate Resisting	Sand Lime

CONCRETE GRADE	CHARACTERISTIC STRENGTH N/mm^2	APPLICATION
No. 1.	1	2 -
No. 2.	1	3 -
No. 3.	1	5 1

RENDERING TO MANHOLE BEDDING

- Rendering to manhole benching shall comprise a 12mm thick layer of approved epoxy mortar.

Manholes Generally

General

Manholes shall be provided at all changes in direction, gradient or diameter.

The manholes shall be of the sizes and grades indicated on the Contract drawings and fully comply with MOPW regulations and Construction Specification

Block work Manholes

Block work manholes shall be constructed on the drain lines in the positions and to the dimensions indicated on Drawings or as directed on site by the Engineer.

The type of construction for each chamber shall be as indicated on the Contract Drawings.

Concrete blocks used for chamber construction shall be manufactured with sulphate resisting cement and shall comply with the requirements of MOPW Construction Specification

Hollow concrete blocks shall be filled solid with concrete Grade SRC 20.

Each manhole shall be built on a minimum of 75mm thick blinding of grade SRC 25 concrete which shall be laid on a dry clean firm foundation free from unsold material. If the bed of the excavation is wet, the top surface of the blinding shall be coated with an approved waterproofing material.

Foundation base slabs shall be cast in-situ. Mass concrete foundation slabs shall be of concrete Grade 20. Reinforced concrete foundation slabs shall be of Grade SRC 30.

Internal and external faces of the block work walls shall be finished with 12mm thick SRC mortar rendering Class 1.

All internal faces of manhole chambers except benching and vitrified clay channel fittings shall be painted with one primer coat and two final coats of black bitumen coating water proofing solution to BS 3416, type 1 or equal and approved.

All exterior faces of manhole chambers shall be protected with 1000-gauge polythene membrane with hardboard protection against damage during backfilling.

Where indicated on the Drainage, manhole cover frames shall be supported on solid precast concrete bricks, manufactured from Grade SRC 30 concrete.

Reinforced cover slabs shall be provided where manhole access openings are less than the internal dimensions of the manhole chamber.

The cover slabs shall be mounted by ductile manhole covers and frames of the quality specified. The covers in roads and paved areas

shall be accurately set on precast concrete brickwork to the level and slopes of the roads or pavements.

Manhole inverts shall be constructed of half section vitrified clay channels. Half section vitrified clay channel branch bends shall be used for branch connections. Benching in manholes shall be carefully formed according to the number, diameter and positions of the incoming and outgoing pipes. The benching in the manholes shall have vertical sides extending from the verified clay channels at least to the level of the crown of the highest pipe. The benching shall be sloped towards the channels at gradient of 1 in 10 or as otherwise detailed on the drawings. The benching shall be rendered with a 12mm thickness of epoxy mortar rendering. The ends of all pipes entering and leaving the manhole are to carefully cut to shape to suit the internal dimensions of the manholes, and shall project through on the inside, the benching being

Continued round the pipe to form a fillet.

Precast Concrete Manholes

The base shall be cast in-situ and shall be Grade SRC 20 concrete to the dimensions shown on the drawings.

The whole base including the outside surround to the pipes shall be cast monolithic. Immediately before concreting, lengths of pipes to be built in shall be surrounded with a layer of cement mortar No. 1.

The formwork for all precast concrete rings shall be purpose made in mild steel and shall incorporate surface vibrators of adequate performance to ensure proper compaction of the concrete. The forms must have provisions for allowing the casting in of the step irons. All precast components for manholes shall be made in accordance with BS 5911 or equivalent approved standard. Precast concrete components shall immediately after the removal of forms, be sprayed with an approved curing membrane. Regular spraying with water will not be an acceptable method of curing.

Where the Contractor does not own forms with surface vibrators for the production of precast concrete manhole components he may, with the written approval of the Engineer employ an approved method of hand compaction. If the Engineer gives such written approval, this does not imply acceptance of the quality of the finished work.

The positions of lifting holes or eyes in precast components are to be approved by the Engineer. Lifting holes are to be grouted up after construction of the manhole.

Step Irons

Step irons are to be positioned in the chamber shaft rings in such manner that the step irons are vertically linear. The joints at each step iron shall be made water-tight and strong, free from any crack and if found otherwise the Engineer may reject the precast ring or may instruct the Contractor to take any necessary measures to make the ring watertight.

The first step iron shall be fixed at a maximum of 600mm below the cover level and the last

step iron shall be fixed at a maximum of 300mm from the top level of the lowest adjacent benching.

Step irons shall be staggered at 300mm centres vertically and horizontally.

All joints between rings or slabs shall be made watertight to the satisfaction of the Engineer with a bituminous mastic strip sealant as approved. The external face of the joint is to be sealed with epoxy mortar.

Chamber Rings

Chamber rings shall be manufactured from concrete Grade SRC 30.

Both internal and external surfaces of the chamber rings shall be coated with a solution of bitumen refined from asphaltic crude oil, the solution having total solids content of approximately 45% and a viscosity corresponding to a No. 4 for cup time of approximately 30 seconds.

Manhole Covers and Frames

In general, manhole covers and frames shall be one of three types, as follows, unless otherwise specified.

- Heavy Duty, to BS 497 Grade A
- Medium Duty, to BS 497 Grade B1
- Light Duty, to BS 497 Grade C

Heavy Duty

All manholes installed in roadways or trafficked areas shall be heavy duty Ductile cover to BS 497 Grade A, Reference MA 60.

The cover and frame shall be made from ductile iron and the cover shall be of the loosely bolted double triangular type with three-point suspension to provide stability under load.

Medium Duty

All manholes installed external to buildings, but not in roadways or trafficked areas, shall be medium duty to BS 497 Grade B1.

The cover and frame shall be of ductile iron and the cover shall be either rectangular or circular as specified in the Manhole Schedule. Such manholes shall incorporate a single seal between cover and frame. Following flushing out and testing of the drainage system, the sealing groove shall be filled with grease to provide an airtight seal.

Light Duty

All manholes installed within buildings and not subject to motor vehicles or industrial trolleys etc. shall be light duty to BS 497 Grade C of the lockable type.

The cover and frame shall be made from grey iron and shall incorporate a double seal between cover and frame. Following flushing out and testing of the drainage system, the sealing grooves shall be filled with grease to provide an airtight seal.

In those areas where it is required to accept a tiled floor finish, the manhole covers shall be of the recessed type. In kitchens, or other areas subject to washing down, manhole covers and frames shall have stainless steel edging and trim. Double-cover units shall be provided where specified in the Manhole schedule.

The Contractor shall provide two sets of lifting keys for each type of manhole.

Manhole covers and frames shall be as approved.

Recessed Covers

Where manholes installed within tiling or decorative floor finish surroundings, a recessed type manhole covers shall be installed.

The cover and frame shall be made from galvanized steel cover and frame and shall incorporate a double seal between cover and frame. Manhole covers shall be fastened to frames by heavy-duty counter sunk screws. Floor finishing shall be rendered continuously within the manhole covers to match the surroundings.

Following flushing out and testing of the drainage system, the sealing grooves shall be filled with neoprene to provide an airtight seal.

In kitchens, or other areas to washing down, manhole covers and frames shall have stainless steel edging and trim. Double-cover units shall be provided where specified in the Manhole schedule.

The Contractor shall provide two sets of lifting keys for each type of manhole.

Manhole covers and frames shall be as approved.

L. Gully Trap (G.T):

Gully Trap size 150 mm: PP of same pipe material, with minimum 7 cm trap seal, one outlet 110 mm and multiple inlets 110 mm complete with heavy duty plastic cover from PP and plate size 20cmx20cm accordance with BS EN 13598 – 1 and BS EN 7158.

M. Camlock Fittings set:

These fittings set as shown on drawings must be size 4” - close tolerance all of them made of 316 grade stainless steel, include:

- Male Adaptor: which is connected with uPVC pipes.
- Female Coupler Cap: it’s a cap for the Male Adaptor.
- Hose Tail Coupler: which is connected with Sewage truck’s hose.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
   2. Locate at each change in direction.
   3. Locate at minimum intervals of 15 m for piping NPS 4 (DN 100) and smaller and 30 m for larger piping.
   4. Locate at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
   2. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

E. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.

J. Install through-penetration fire-stop assemblies in plastic conductors and stacks at floor penetrations.

K. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions

Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
   1. Position roof drains for easy access and maintenance.

L. Install deep-seal traps on floor drains and other waste outlets, if indicated.

M. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
   1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
   2. Size: Same as floor drain inlet.

N. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

P. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

Q. Install vent caps on each vent pipe passing through roof.

R. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain (25-mm) clearance between vent pipe and roof substrate.

S. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

T. Install grease separators, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
   1. Above-Floor Installation: Set unit with bottom resting on floor, unless otherwise indicated.
   2. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
   3. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.
   4. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.

U. Install oil separators, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and manufacturer recommendations.

V. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
   1. Grease separator
   2. Oil separator

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled grease removal devices and their installation, including piping and electrical connections, and to assist in testing.

B. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Apply static test of 3.0m head for at least two hours.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain grease and oil separators.

END OF SECTION 15155

SECTION 15410

COLD WATER SERVICES

INDEX

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2	Pipework General
3	Valves
4	Thermal Insulation
5	CPVC Pipework
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11	Float Valves
12	Pressure Sensors
13	Hose Bib
14	Pressure Reducing Valve
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16	Packaged Booster lifting Pump set
17	Reverse Osmosis Unit (RO)
18	Electric Water Heater (EWH).
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SECTION 15410

COLD WATER SERVICES

1 GENERAL REQUIREMENTS

The cold water system shall be executed as shown on the drawings, complete with all water distribution piping, water reservoir piping, pumps, etc.

The Contractor shall be responsible for providing the main cold water supply pipe and accessories from the mains including obtaining the necessary permits, performing all legal matters and making the tie-in to the water source in accordance with local codes, regulations and requirements of the water authorities having jurisdiction and including the provision of the water meter or orifice installation as might be required and as instructed by the authorities or the Engineer, all on his own account.

Underground water pipes shall not be run in the same trench as sewer pipes. Adequate precautions shall be taken for protecting underground water pipes from contamination from any source.

Flow control devices shall be provided on cold water service branches to maintain the design velocities. The process of regulating flows irrespective of pressure should also achieve a degree of water conservation.

2 PIPEWORK GENERAL

The pipework shall be as specified in section 15020 / Plumbing and Fire Fighting of these specifications unless otherwise mentioned in this section.

3 VALVES

The valves shall be as specified in section 15020 / Plumbing and Fire Fighting of the specifications unless otherwise mentioned in this section.

4 THERMAL INSULATION

All cold water pipework inside the building shall not be thermally insulated.

5 CPVC PIPEWORK

Refer to section 15020 / Plumbing and Fire Fighting.

6 STRAINERS

Refer to Section (15020).

7 FLUSHING

The whole of the pipework installation shall be flushed out as detailed in section (15020) of these specifications.

8 TESTING AND COMMISSIONING

The testing and commissioning of the cold water services shall be carried out as described in section (15020) of these specifications.

9 CHLORINATION

After testing of the pipework and prior to making the connection to the new town mains supply all pipework shall be satisfactorily chlorinated in accordance with BS Code of Practice No. 310.

10 Concrete Water Reservoir Accessories:

The Contractor shall be responsible for furnishing and installing all piping connections, into the water reservoirs such as water inlets, vents, overflows, drains, puddle flanges, pump suctions, stainless steel 316 leaders on both sides and stainless steel 316 louver door openings, …etc., as shown on the drawings and of sizes as shown thereon.

The Contractor shall install the piping connections into the walls of the reservoirs at the time the concrete is poured. He shall be responsible for correctly locating the connections at their exact required locations and for taking the necessary precautions not to have them dislocated when concrete is poured and for preventing concrete from entering into them.

Piping connections into the reservoirs shall be of stainless steel 316 pipe, with threaded ends for connecting to threaded fittings and valves and with flanges screwed on to them where it is necessary to connect them to flanged fittings or valves. They shall be of suitable lengths to project 5 cm. within the reservoirs and 15 cm. beyond the outside wall of the reservoirs.

All piping connections embedded in the concrete walls of the reservoirs shall be provided with no-leak flanges which shall consist of a square stainless steel 316 plate, 6 mm. thick, of dimensions 15 cm. larger than the pipe, with a hole in the center equal to the outside diameter of the pipe. The flange shall be welded all around the pipe at a location as to fit in the center of the wall to prevent water leakage around the pipes all as detailed on the drawings.

Open ended piping connections into the reservoirs such as vents and overflows shall be properly screened to prevent the entrance of insects, vermine and foreign matter into the reservoirs. The screens shall be of galvanized steel wire mesh not less than 10 mesh per square centimeter and shall be fitted to the open end of the pipe in an approved manner.

The entrance of pump suction pipe in the water reservoir shall be provided with stainless steel vortex plate.

11 FLOAT VALVES

Float valves shall be of all brass construction including levers and arms, with plastic float and shall be suitable for a cold water working pressure of 10 bar. Float valves size 50 mm. and smaller shall have screwed inlets and size 65 mm. and larger shall have flanged or grooved inlets.

Float valves shall be of the full bore, equilibrium ball type, designed to close tight against maximum pressure when half submerged. They shall have renewable synthetic rubber valve disk and balancing piston bucket.

Float valves shall conform to BS 1212 and BS 1968.

12 PRESSURE SENSORS

Pressure sensors shall be installed in strategic points in the cold water systems as recommended by the pump set manufacturer.

The pressure sensors shall be connected to the main domestic cold and softened water boosting sets. This is maintain the required pressure throughout the circuit which serves all buildings.

13 HOSE BIB

Hose Bib shall be finished chrome plated red brass, compression type with four arm cross removable metal handle and standard hose threads.

14 PRESSURE REDUCING VALVE

Valve shall be such that complete replacement of inspection of any part can be made without removal of the valve body from the pipe. Valve shall be provided with a by- pass arrangement complete with all valves and pressure gauges, as detailed on the drawings (for more details refer to section 15020).

15 PACKAGED VARIABLE SPEED BOOSTER PUMP SET (FOR DOMESTIC COLD WATER) (DCWBP-1)

The booster pump set shall be completely automatic and skid mounted unit assembled. The pumps installed on the pump set shall be approved by WRAS.

The pump manufacturer shall have been in the business of manufacturing complete pumping systems for minimum of 10 years.

The pump set shall maintain constant delivery pressure by means of a frequency converter for each pump to control speed of pumps.

Pump set shall include the following features:-

1. Two vertical multi-stage pumps with high efficiency motors and drives.
2. Variable frequency driver with digital read out for each pump to be installed inside the control panel.
3. Copper or stainless steel suction and delivery manifolds with flanged connections.
4. Copper ball isolating valves and flexible connections on suction and delivery for each pump.
5. Check valves on delivery for each pump.
6. Strainer on suction on the main connection pipe for the pump header.
7. Pressure gauge at discharge manifold and transducer pressure
8. Control panel.
9. Pressure vessel on discharge main fold as recommended by the pump manufacturer.
10. Weather resistance painted Heavy-duty steel metal louvered box with door.

11. Skid plate shall be heavy duty epoxy painted equipped with vibration absorber.

The pumps impellers, guide vanes, shafts and outer sleeves shall be stainless steel.

The pump motor shall be squirrel cage induction type and rated for continuous operation at ambient temperature not less than 50°C.

The motors shall be totally enclosed fan cooled type with insulation class (F) and IP54 protection and rated for 400 volt, 3-phase and 50 cycle.

The control panel shall be constructed of 1.5 mm thickness sheet steel and IP65 protection.
The control panel shall include all features and components shown in the drawings.

The sequence of operation described in the drawings shall be tested at the completion of the works.

QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of all pumps types, sizes and capacities required, whose products have been in satisfactory use in similar service for not less than 10 years.

B. The Agent or Authorized Dealer should be representing directly the manufacturer, a formal letter should be issued in the name of the Agent or Authorized Dealer directly from the manufacturer.

C. The Agent or Authorized Dealer should be registered in Jordan for not less than 5 years, and should have experience in selling, installing and maintaining punps systems in Jordan.

D. Guarantee: **The pump set shall be the latest and newest model and latest technology for the manufacturer products** and shall include a (2) two years full guarantee, full warranty and full preventive maintenance on all parts and labor after acceptance by the Engineer and the owner including regular visits two times a year and upon request (cost of spare parts ,labor and regular visits and upon request deemed to be included in the contractor's cost for the two years after acceptance) .

E.

16 PACKAGED BOOSTER LIFTING PUMP SET (FOR DOMESTIC COLD WATER) (LP-1)

The booster pump set shall be completely automatic and skid mounted unit assembled. The pumps installed on the pump set shall be approved by WRAS.

The pump manufacturer shall have been in the business of manufacturing pumping systems for minimum of 10 years.

Pump set shall include the following features:-

1. Two Vertical multi-stage pumps with high efficiency motors and drives.

2. Copper or stainless steel suction and delivery manifolds with flanged connections.
3. Copper ball isolating valves and flexible connections on suction and delivery for each pump.
4. Check valves on delivery for each pump.
5. Strainer on suction on the main connection pipe for the pump header.
6. Pressure gauge at discharge manifold.
7. Control panel.
8. Skid plate shall be heavy-duty epoxy painted equipped with vibration absorber.
9. Weather resistance painted Heavy-duty steel metal louvered box with door.

The pumps impellers, guide vanes, shafts and outer sleeves shall be stainless steel.

The pump motor shall be squirrel cage induction type and rated for continuous operation at ambient temperature not less than 50°C.

The motors shall be totally enclosed fan cooled type with insulation class (F) and IP54 protection and rated for 400 volt, 3-phase and 50 cycle.

The control panel shall be 1.5 mm thickness sheet steel and IP65 protection.

The control panel shall include all features and components shown in the drawings.

The sequence of operation described in the drawings shall be tested at the completion of the works.

QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of all pumps types, sizes and capacities required, whose products have been in satisfactory use in similar service for not less than 10 years.

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C. The Agent or Authorized Dealer should be registered in Jordan for not less than 5 years, and should have experience in selling, installing and maintaining pumps systems in Jordan.

D. Guarantee: **The pump set shall be the latest and newest model and latest technology for the manufacturer products** and shall include a (2) two years full guarantee, full warranty and full preventive maintenance on all parts and labor after acceptance by the Engineer and the owner including regular visits two times a year and upon request (cost of spare parts ,labor and regular visits and upon request deemed to be included in the contractor's cost for the two years after acceptance) .

17 Reverse Osmosis Unit (RO)

RO unit shall be package type with tank and presser pump, its hall have a seven stages filtration process including a UV minimum production rate shall be 4 L/Hour, the RO unit shall be USA manufactured origin.

18 Electric Water Heater (EWH)

Small sizes electrical heaters shall be furnished with residential (EWH). The residential electric water heater shall be of storage type with heating capacity and storage capacity on schedule of equipment. Heater shall be rated at 240 volt single phase, 50 HZ and UL listed and approved. Heaters shall have a maximum working pressure of 10 bars. And an energy factor of 0.95 or greater.

The tank shall be of double skin injected with insulation foam of R21 insulation value. The jacket shall full size compartments for the performance of service and maintenance through front panel openings and enclose the tank with foam insulation.

The internal surfaces of the cylinder shall be of glass lined.

The outer surface shall be treated cleaned and bake enamel paint finished for extra protection against corrosion

The tank shall be provided with 20mm tapping and temperature pressure relief valve and with a sacrificial anode rod for maximum cathodic protection. The tanks shall also be provided with two isolating valves, vacuum breaker, non return valves, drain cock and thermometer.

The controls shall include a thermostat with each element and high temperature cut out switch.

19 Horizontal & Vertical Polyethylene TANK

Food grade Polyethylene tanks shall be constructed from 6 layers:
as per followings:

1. First Layer (External): prevents dust absorption and blocks UV ray that could result to material degradation, comes in various colors as desired by the client.

2. Second Layer (Black): makes the tank opaque. Thus, preventing growth of microorganisms.

3. Third , Fourth and Fifth Layers: isolating outside temperature or providing insulation to keep water temperature less affected by heat especially during summer.

4. Sixth Layer (Inner White): a layer of smooth snow-white to prevent any accumulation of impurities or bacterial growth in the inner surface of the tank. It is also resistant to corrosion & Erosion. to keeps the water healthy and pure.

The tank lid shall be strong enough to allow a man to safety work on it. The tank shall be complete with a hinged & lockable lid and air vents. The tanks shall be mounted on 200mm clear height, galvanized steel strip plinths.

The tanks shall be hydraulically tested on site for 48 hours. If there are any leaks the tank shall be repaired and re-tested. On completion of testing and prior to putting the tank in use, it shall be carefully cleaned thoroughly and disinfected.

All tanks operating at atmospheric pressure shall be tested under "tank full" conditions for tightness and structural soundness.
All potable water tanks shall be subject to a standing leak test for 24 hours, during which time all joints shall be carefully examined. Any defects shall be rectified immediately and the test repeated.

END OF SECTION 15410

SECTION 15430

PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Division-1 Specification sections apply to work of this section. All fixtures shall need prior approval from the Engineer.

1.2 SUMMARY

A. Provide materials, labor, trim and services for the complete installation of plumbing fixtures and related components as indicated on the drawings and specified herein.

1.3 DEFINITIONS

A. Accessible: Plumbing fixture, building, facility, or portion thereof that can be approached, entered, and used by physically handicapped, disabled, and elderly people.

B. Fitting: Device that controls flow of water into or out of plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, drains and tailpieces, traps and waste pipes. Pipe fittings, tube fittings, and general-duty valves are included where indicated.

1.4 REFERENCES

A. The plumbing fixtures shall comply fully with the latest relevant British and International Standards in all respects.

1.5 WORK CLEANLINESS

A. General: The Contractor shall proceed with all work in a clean and workmanlike manner. Contractor shall keep stored materials, storage areas, and installed systems free of dirt and debris.

B. Provide protective covering for installed fixtures and fittings.

C. Do not allow use of fixtures for temporary facilities, except when approved in writing by Engineer.

1.6 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of plumbing fixtures, whose products have been in satisfactory use in similar service for not less than 5 years.

B. The Agent or Authorized Dealer should be representing directly the manufacturer, a formal letter should be issued in the name of the Agent or Authorized Dealer directly from the manufacturer.

C. The Agent or Authorized Dealer should be registered in Jordan for not less than 5years, and should have experience in selling, installing and maintaining solar systems in Jordan.

D. Guarantee: **plumbing fixtures shall be the latest and newest model and latest technology for the manufacturer products** and shall include a (5) five years full guarantee, full warranty and full preventive maintenance on all parts and labor after acceptance by the Engineer and the owner including regular visits three times a year and upon request (cost of spare parts ,labor and regular visits and upon request deemed to be included in the contractor's cost for the five years after acceptance . **The Agent or Authorized Dealer shall provide a letter directly to the owner for his commitment on this clause.**

1.7 GENERAL REQUIREMENTS

A. Plumbing fixtures, trim, and accessories shall be from one approved brand, unless otherwise specified.

B. Vitreous ware for the fixtures shall be first quality, non absorbent china. Enamel ware shall be constructed of smooth sound iron castings. Fittings for fixtures shall be first quality in heavy red brass castings properly finished and high quality chrome plated. All wall hung fixtures to be caulked between walls and fixtures. All fixtures should be of vandal proof type.

C. Final type, selection and color of vitreous china fixtures will be decided according to the Architect or Interior Decorator requirements and approval.

D. All specified accessories used in disabled toilets, should be certified for the use by disabled people.

E. All Plumbing fixtures should be delivered to the site complete with all related approved accessories and ancillaries as specified here in this section.

1.8 PROTECTIVE SHELDING GUARDS

A. Protective Shielding Pipe Covers:
   1. Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping.

B. Protective Shielding PipingEnclosures:
   2. Manufactured plastic enclosure for covering plumbing hot- and cold-water supplies and trap and drain piping.

1.**9** DELIVERY, STORAGE, AND HANDLING

A. Deliver plumbing fixtures in manufacturer's protective packing, crating, and covering.

B. Store plumbing fixtures on elevated platforms in dry location.

PART 2 - PRODUCTS

2.1 PLUMBING FIXTURE STANDARDS (Refer to details)

2.2 LAVATORIES

A. White vitreous china countertop or semi-pedestal type lavatory with one tap hole for mixer as shown on drawings. Lavatories to be completed with the following trim and accessories:
- Chrome plated P-trap with wall tube and wall flange, adjustable type.
- Wall brackets and Brass chrome plated drain shall be provided
- Two 15mm stop angle valves with 300mm tubes with wall flanges. Similar to (Grohe 22951 00M) or approved equal on quality and appearance.
- The fixture unit and 15mm single hole chrome plated mixer shall be as Described below:

A.1 Lavatory Type (L-1): With Counter Type, size (550x450mm) shall be similar to (Keramag- Impuls 251555) or approved equal on quality and appearance.
And shall be completed with single lever basin mixer, furnished with 35mm ceramic cartridge, adjustable flow limiter, Adjustable minimum flow rate 2.5 lit/min, mousseur, automatic pop-up waste set 32mm, flexible connection hoses. Similar to (Grohe-Eurodisc23449002) or approved equal on quality and appearance.

A.2 Lavatory Type (L-2): Lavatory size (650x550mm) accessible handicapped type similar to (Keramag-Vetalis 221556) or approved equal on quality and appearance.
And shall be completed with 35mm ceramic cartridge, adjustable flow limiter, Adjustable minimum flow rate 2.5 lit/min, mousseur, automatic pop-up waste set 32mm, flexible connection hoses. Similar to (Grohe-Eurodisc23449002 or approved equal on quality and appearance.

2.3WATER CLOSETS

A. Water Closet: Wall hung type as per Architectural requirements and as indicated on drawings, white vitreous China. Water closet to be complete with the following trim and accessories:

1. White solid plastic seat and cover complete with ABS chrome plated hinge, rubber washers, and chrome plated screws and nuts.
2. Supporting system for WC.

- Concealed flush tank with fittings and accessories screwed to wall complete with actuator plate, as shown on drawings and as described hereunder:

A.1 Water Closet type (WC-1),Wall Hung,Size (540x355mm) shall be similar to (Keramag-Impuls 201550) or approved equal on quality and appearance, from the proposed manufacturer list only.

Water closet to be complete with the following trim and accessories:
White solid plastic seat and cover complete with ABS chrome plated hinge, rubber washers, and chrome plated screws and nuts.

Shall be completed with flushing system consist of powder coated steel frame, self-supporting for dry-cladding, completely pre-assembled with fixed connections quick adjustment, lockable fixing material
TÜV approved, 2 WC fixing bolts, fixing device for ceramic
WC ceramics with small bearing area (< 205 mm), outlet bend Ø 90 mm depth, adjustable reducer Ø 90/110 mm, inlet and outlet connecting set similar to (Grohe Rapid SL 38528001).

CISTERN
Adjustment ex. factory 6 L and 3 L, pneumatic discharge valve offering 3 modes of operation: dual flush or start/stop or single flush. water supply from left/right or back. low noise (group I acc. To German Noise Specification). insulated against condensation. ½" water supply connection including integrated, angle valve and push fit flexible hose union, no tools required for the installation of the inspection shaft incl. protection during construction phase.
with Chrome plated Cover plate (similar to Grohe GD2) or approved equal on quality and appearance.

A.2 Water Closet type (WC-2), Wall hang accessible handicapped type as per Architectural requirements and as indicated on drawings, white vitreous china. Size (700x355mm) shall be similar to (Keramag-Vitalis 201500) or approved equal on quality and appearance.
Water closet to be complete with the following trim and accessories:
White solid plastic seat and cover complete with ABS chrome plated hinge, rubber washers, and chrome plated screws and nuts.
Shall be completed with flushing system consist of powder coated steel frame, self-supporting for dry-cladding, completely pre-assembled with fixed connections quick adjustment, lockable fixing material
TÜV approved, 2 WC fixing bolts, fixing device for ceramic

WC ceramics with small bearing area (< 205 mm), outlet bend Ø 90 mm depth, adjustable reducer Ø 90/110 mm, inlet and outlet connecting set similar to (Grohe Rapid SL 38528001) or approved equal on quality and appearance.

CISTERN

Adjustment ex. factory 6 l and 3 l, pneumatic discharge valve offering 3 modes of operation: dual flush or start/stop or single flush. water supply from left/right or back. low noise (group I acc. To German Noise Specification). insulated against condensation. ½" water supply connection including integrated, angle valve and push fit flexible hose union, no tools required for the installation of the inspection shaft incl. protection during construction phase.
with Chrome plated Cover plate (similar to Grohe GD2) or approved equal on quality and appearance.

2.4 KITCHEN SINKS (KS-1)

Stainless Steel, type 304, 1.6mm thickness insert type for fixing into counter top, single bowl and drainer, size (1200x435mm).

A. Sink to be complete with the following trim and accessories.
- 50mm sink waste with stainless steel grating.
- P-trap with wall tube and escutcheon.
- Wall flange for 50mm tube trap.
- 15mm chrome plated single lever sink mixer, with swivel Tubular U-spout, sink mounted complete with stop valves and chrome plated flexible connection hoses with ceramic cartridge. Similar to (Grohe 32488 000) or approved equal on quality and appearance.
- 15mm stop angle valves with flexible tubing and wall flange.

2.5 HAND SPRAY WASH ASSEMBLY (HS)

A. Bibcock with perineal hose: to be of very heavy duty, vandal proof type trigger sprays hand shower head, with wall holder, wall mounted angle valve, and heavy duty chrome plated metal 15mm flexible tube of 1200 mm long. 15mm chrome plated, wall mounted angle valve type with standard threaded outlet. Complete with pressure reducing fitting.

2.7 MISCELLANEOUS ITEMS

A. Flexible tube used for connecting the mixers and taps to angle valves on water inlet, should be of the first quality, heavy duty type, and should be from the same manufacturer of the fixture and to be approved by the Engineer prior to installation.

2.8 FITTINGS

A. Fittings for Equipment Specified in Other Sections: Fittings include the following:
   1. Supply Inlets: Brass pipe or copper tube, size required for final connection.
   2. Supply Stops: Chrome-plated brass, angle or straight; compression, wheel-handle type; same size as supply inlet and with outlet matching supply riser.
   3. Supply Risers: DN10 (3/8-inch NPS) flexible copper tube with knob end. Use chrome-plated tube for exposed applications.
   4. Traps: Tubular brass with 1.1 mm (0.045-inch) wall thickness, with no-leak slip-joint inlet, cleanout, wall flange, escutcheons, and size to match equipment. Use chrome-plated tube for exposed applications.
   5. Continuous Waste: Tubular plastic with no-leak slip-joint inlet and size to match equipment.
   6. Indirect Waste: Tubular plastic and size to match equipment.

PART 3 - EXECUTION

3.1 VERIFICATION OF CONDITIONS

A. Examine the substrates, adjoining construction, and conditions under which the work would be installed. Contractor shall correct unsatisfactory conditions detrimental to the timely and proper completion of the work. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Assemble plumbing fixtures and trim, fittings, faucets, and other components according to manufacturers' written instructions.

B. Install fixtures level and plumb according to manufacturer's written instructions, roughing-in drawings, and referenced standards.

C. Fasten wall-hanging plumbing fixtures securely to supports attached to building substrate when supports are specified, and to building wall construction when no support is indicated.

D. Install individual stop valve in each water supply to fixture. Use gate or globe valve where specific stop valve is not specified.

E. Install water supply stop valves in accessible locations.

F. Install traps on fixture outlets. Omit traps on fixtures having integral traps. Omit traps on indirect wastes, except where otherwise indicated.

G. Install escutcheons at wall, floor, and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons where required to conceal protruding pipe fittings.

H. Seal joints between fixtures and walls, floors, and counters using sanitary-type, 1 part, mildew-resistant, silicone sealant.

3.3 CONNECTIONS

A. Concealed brackets, hangers and plates shall have a shop coat of paint.
- All exposed piping and trim shall be chrome plated and fully protected during installation. Strap or padded wrenches shall be used on chrome pipe fittings and valves.
- All exposed metal parts in the sanitary blocks shall be chrome plated.
- All exposed valves in the sanitary blocks shall be chrome plated of the recessed type.

B. Plumbing fixtures shall be complete with all required trimmings, including faucets, waste plugs, traps, supplies, stop valves, escutcheons and casings and all necessary hangers, plates, brackets, anchors and supports.

3. Fixtures shall be set in a neat, finished and uniform manner making the connection to all fixtures at right angles with the walls, unless otherwise directed by the Engineer.
   - Roughing for this work must be accurately laid out so as to conform with the finished wall material.
   - Fixtures are not to be set until so directed by the Engineer.

C. The location and disposition of all items shall be as indicated on the relevant or drawings.

D. Install piping connection between plumbing fixtures and piping systems and plumbing equipment.

E. Arrange for electric power connections to fixtures and devices that require power.

3.4 FIELD QUALITY CONTROL

A. After the piping has been pressure tested, and the fixtures have been set and trim piped, but prior to practical completion, each fixture supply and drain shall be flowed to observe proper dynamic action to the set.

B. Contractor shall notify the Engineer in writing at such time as the potable water systems, drainage, waste and vent piping, and plumbing fixtures are complete and ready to be flow tested on an acceptable basis.

C. Check that fixtures are complete with trim, faucets, fittings and other components.

3.5 EQUIPMENT HANDLING

A. The Contractor shall furnish all supervision, labor, tools and equipment to relieve, unload, uncrate, inspect, move, disassemble, store, assemble, set in place, align and secure all equipment including all auxiliary items and components.

B. Adequate weather protection of all equipment and equipment parts is to be furnished and maintained at all times by the Contractor

C. Stored equipment shall be protected from the elements and physical damage. Installed equipment shall be protected from damage until final acceptance.

3.6 ADJUSTING AND CLEANING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Operate and adjust disposers, hot-water dispensers, and controls. Replace damaged and malfunctioning units and controls.

C. Adjust water pressure at faucets and flush tanks having controls, to produce proper flow and stream.

D. Replace washers and seals of leaking and dripping faucets and stops.

E. Clean fixtures, faucets, and other fittings, including flush tanks, with manufacturers' recommended cleaning methods and materials. Include the following:
   1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
   2. Remove sediment and debris from flush tanks and drains.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of fixtures for temporary facilities, except when approved in writing by Engineer.

END OF SECTION 15430

SECTION 15490

Solar Collectors System

General Description:

The system shall has maximum efficiency levels and responds to the EN 12975 and EN 12976 Standard.
The storage tank is placed horizontally and always directly above the collector. Once the heat-carrying fluid is heated inside the collector, it becomes less dense and rises towards the indirect cylinder where the heat is then released into the water contained in the cylinder. After the thermal exchange, the heat carrying fluid cools, becomes dense and descends back down to the solar collector where it is heated again.

System classification:

Flow principle	Thermosyphon
Direct/ indirect	Indirect (closed type)
Storage location	Outdoor
Storage position	Horizontal

Products:

1.1 FLAT PLATE SOLAR COLLECTORS (3NOs):

A. Flat collector shall be equipped with copper or aluminum Absorber and blue selective coating.
B. Ultra sound / laser welded piping.
C. Absorption Coating; Three layers including Aluminum Nitrate; which is characterized by very low emission and very good absorption.
D. Important Specs:
   - Absorber area ≥ 2m²
   - Absorption Rate ≥ 95%
   - Emission Rate (80±5 °C) ≤ 5%
   - Glass ≥ 3 mm tempered
   - Transparent ≥ 90%
   - Insulation 50mm rock wool
   - Stagnation temperature 160 °C
   - Maximum working pressure 6 bar
E. Collectors to be tested and approved by certified third party like Solar keymark or approved equal. The following tests certificates are required:
   a. Thermal Shock Test

b. Hailstone Test
c. Efficiency

1.2 HOT WATER STORAGE TANK (300LIT):

A. Steel Cylinder with titanium-based enamel treatment at 850°C.
B. Anti-corrosion large magnesium anode.
C. Wide front flange for inspection and cleaning
D. Equipped for thermostat, electric heating element
E. High heat insulation by means of polyurethane foam
F. Anti-corrosion, weather proof external casing.
G. Working Pressure shall be more than 6 bar.
H. Wide front flange for inspection and cleaning
I. Back up heating element 4.0 kW
J. Safety Valve shall be installed in the system

1.3 Solar Collector Frames:

Very rigid with high resistance to wind and weather conditions, made of high quality zinc coated steel plates.

1.4 Hot Water Circulating Pump (DHWRP-1)

A. General Description: Horizontal, in line, centrifugal, single stage, rated for (860-kPa) minimum working pressure and (107 deg C) continuous water temperature.
   1. In-Line Circulator: Horizontal, in-line, centrifugal, single stage with threaded companion flanges for piping connections smaller than (65mm), and threaded gage tappings at inlet and outlet connections.
   2. Impeller: rolled-temper brass, statically and dynamically balanced, closed, overhung, single suction, and keyed to shaft.
   3. Shaft and Sleeve: Steel shaft with oil-lubricated copper sleeve or ceramic shaft.
   4. Mechanical Seals: Carbon steel rotating ring, stainless-steel spring, ceramic seat, and flexible bellows and gasket.
   5. Pump Bearings: Permanently lubricated ball bearings.
   6. Motor Bearings: Permanently lubricated ball bearings.
   7. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
   8. Motor: Resiliently mounted to the pump casing.
   9. Selection parameters: Flow = 0.10 LPS, Head = 4.00mH_2O.

1.5 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of solar types systems sizes and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. The Agent or Authorized Dealer should be representing directly the manufacturer, a formal letter should be issued in the name of the Agent or Authorized Dealer directly from the manufacturer.

C. The Agent or Authorized Dealer should be registered in Jordan for not less than 3 years, and should have experience in selling, installing and maintaining solar systems in Jordan.

D. Guarantee: **The Solar system shall be the latest and newest model and latest technology for the manufacturer products** and shall include a (2) two

E. years full guarantee, full warranty and full preventive maintenance on all parts and labor after acceptance by the Engineer and the owner including regular visits two times a year and upon request (cost of spare parts ,labor and regular visits and upon request deemed to be included in the contractor's cost for the five years after acceptance) for the solar system and Hot Water Circulating Pump .

END OF SECTION 15490

SECTION 15520

FIRE FIGHTING SERVICES

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9	Field Acceptance Tests and Maintenance
10	Fire Fighting Pumping Unit (PACKAGED Pumpset)
11	FM-200 System
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SECTION 15520

FIRE FIGHTING SERVICES

1 SCOPE OF WORK

The fire fighting services shall be executed as shown on the drawings. All fire fighting components and equipment shall be approved by the Local Civil Defense Department and shall be according to NFPA and UL listed and FM approved except for hose reels.

2 PIPEWORK

2.1 General Requirements

- All pipes shall be of sizes and general routing as shown on the contract drawings.
- Valves shall be of the same size as the pipe run in which it is installed.
- Piping material shall be as specified hereafter.
- Pipes shall be installed in a neat manner to present a neat and pleasing appearance.
- Pipes shall be installed in a manner to permit free expansion and contraction without causing damages to piping or construction. Adequate offsets and change of direction in the piping shall be provided to accomplish this. On long pipe runs expansions loops or expansion joints shall be provided. Where expansion joints are used careful consideration shall be given to anchoring and guiding the pipes for controlled expansion and contraction.
- Adequate clearance shall be left between pipes and adjacent surfaces or existing installations for the easy installation of valves and accessories.
- Drain valves shall be provided at all low points and as required to permit draining any part of the system for maintenance and repair irrespective whether they are shown on the Contract drawings or not. Drain valves shall also be provided for alarm valves as shown on the Contract drawings for the purpose of testing the system.
- When water filled supply pipes pass through open areas or other areas exposed to freezing, the pipe shall be protected against freezing by insulating coverings and 1mm aluminum thickness cladding.
- The Contractor shall inspect the site conditions for verifying the required clearance and space necessary for the installation of all pipe work.

2.2 Pipes and Fittings

- All fire fighting and drain piping shall be standard weight seamless steel pipe to ASTM – A53 grade B schedule 40.

- Black steel piping shall be used for fire fighting system, and galvanized steel piping shall be used for drain pipework and for fire fighting pipe network inside pump room.

- Black steel pipes size 50mm and smaller shall be joined by threading, and pipes size 65 mm and larger shall be joined by grooved coupling system.

- Galvanized steel pipes shall be joined by threading for size 50mm and smaller and pipes size 65mm and larger shall be joined by grooved coupling system.

- Fittings on black steel pipes shall be black, and on galvanized steel pipes shall be galvanized. The use of black fittings on galvanized pipes will not be permitted.

- All fittings for black steel pipes size 50 mm and smaller shall be screwed malleable iron fittings, to ANSI B16.3 or equal BS Standard.

- All couplings for black steel pipes 65mm and larger shall be made by mechanical rigid of ductile iron. The fittings shall be grooved ends. Couplings and fittings shall be FM and UL listed.

- For galvanized pipework, the fittings and couplings shall be same as for black steel pipes except they shall be galvanized.

- All threaded and grooved fittings shall be of 16 bar working pressure rating.

- All threaded fittings and pipe shall have threads cut to ANSI/ASTME Standard B1.20.1 or equal BS.

- All fittings shall have the same thickness and be the same schedule and rating as the pipe of the corresponding size.

- All changes in direction, change in pipe size, branching and jointing of pipes shall be made with regular pipe fittings such as elbows, reducers, tees, coupling, unions, flanges, etc. Bending of pipes for elbows and field-fabricated fittings will not be permitted.

- Elbows shall be of the long radius type.

- Branch connection on black steel pipes shall be made with reduced grooved end tees.

- Pipes shall be cut square and to the exact length with a hacksaw or pipe cutting device and the cut end of the pipe shall be reamed with a special tool to the full inside diameter and all chips shall be removed.

- Threads shall be cut with new dies and all burrs and chips formed in the threading operation shall be removed with wire mesh.

- Threaded joints shall be made up tight with approved Teflon tape thread sealant. Lamp wick, cord, wool, or any other similar material will not be permitted in making up threaded joints.

- Grooved joints on black steel pipes shall be made with grooving machine.

- Care shall be taken that the pipe does not intended into the fittings sufficiently to reduce the water flow.

2.3 GROOVED JOINT COUPLING

Grooved joint couplings shall consist of two ductile iron housing segments to BS 1563, pressure responsive gasket to BS 2494, Gaskets shall be molded and produced by the coupling manufacturer, and zinc electroplated steel bolts and nuts. Tongue and recess type couplings which require the use of a torque wrench to achieve the exact required gap between housings are not permitted. Butt joining systems that require full connection between pipes with in the couplings are not acceptable, Groove Joints manufacturers to be of USA and/or European origin only.

1. Rigid Type: Installation Ready rigid joints are designed for direct installation into grooved pipe without prior disassembly of the coupling with an internal lip working as a mechanical stopper to indicate gasket seat surface area on pipe for the installer. Coupling housings shall be cast with offsetting angle-pattern bolt pads to provide rigidity with grade “EHP” (high performance Grade “E” gasket), suitable for water service.

   For 350mm and Larger: Advanced Grooving System is required (AGS), with lead-in chamfer on housing key and wide width Flush Seal gasket. similar to or approved equal

   a) Victaulic Style 009-EZ and Style 107H. Installation-Ready, for direct stab installation without field disassembly.
   b) Victaulic FireLock Style 005 or Zero-Flex Style 07.

2. Flexible Type: For use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Victaulic Installation-Ready Style 177 and Style 77.

   a) Flexible joints may be used in lieu of flexible connectors at equipment connections. Three couplings, for each connector, shall be placed in close proximity to the vibration source.
   b) Flexible joints may be used in lieu of expansion joints as recommended by groove system manufacturer

3. Grooved Fittings: 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.

4. Branch Outlets - Hole Cut Pipe: Hole cut branch outlets or “Mechanical T” branch connections shall have 27 bar pressure ratings or more with locating collar emerging into the hole. Gaskets shall be Grade E standard pressure responsive gasket

2.4 Unions and Flanges

- Pipe unions or flanges, depending on size and material of piping, shall be provided at piping connections to equipment and valves, control valves, and other accessories that need to be taken out for replacement, cleaning or repair.

- Unions or flanges shall also be provided at adequate intervals, in the piping to permit easy disassembly for alteration and repair.

- Disconnecting unions or flanges shall be installed between the equipment and the isolating valves.

- Unions used on threaded pipe size 50mm and smaller shall have female threaded ends and ground metal-to-metal seats.

- Flanges shall always match the flanges provided on valves and equipment as far as pressure rating, facing, drilling and thickness.

- Flanges on black steel and galvanized piping shall be flange adapters and shall be UL and FM.

2.5 Return Bends

Return bends shall be installed for pendent type sprinklers except for dry pendent sprinklers. Return bends shall be connected to the top of branch lines in order to avoid accumulation of sediment in the drop nipples connected to the pendent sprinklers. Return bends shall be installed as detailed on the drawings.

2.6 Pipe Hangers and Supports

REFER TO SECTION (15020).

3 VALVES

3.1 General

- All valves connected to fire fighting system piping shall be of groovedend butterfly type with built in tamper switch and shall be listed fro 175 PSI working pressure for sizes 65mm and above.

- Check valves shall be non slam type, swing pattern, renewable disk, grooved ends iron body and bolted cap for valves size 65mm and larger.

- All check valves shall be suitable for horizontal or vertical installations.

- All butterfly valves, check valves, strainers …etc. for sizes 65mm and above, shall be FM and UL listed.

- For all valves, check valves , strainers, … etc. refer to section (15020).

3.2 Indicating Valves

- All indicating valves on the pump suction shall be outside screw and yoke "OS&Y" gate valves with rising stem that indicates if the valve is open or closed.

- Indicating valves shall not close in less than 5 seconds when operated at maximum possible speed from the fully open position to avoid damage to piping by water hammer.

- Indicating valves shall be grooved end, solid wedge disk.

- Indicating valves shall be cast iron body with bolted bonnets for valve size 65mm and larger.

- Indicating valves shall be supplied with supervisory temper switches, which shall be connected to the main control fire panel.

- All indicating valves and supervisory tamper switch shall be FM and UL listed.

4 FIRE HOSE CABINETS (FHC)

The fire hose cabinet shall be double doors automatic swinging recessed or exposed type according to the drawings and BOQ.

The cabinet shall be to include the fire hose reel and the fire extinguisher. The hose reel shall be mounted on pivoting door for ease of access.

Hose reels shall be automatic type with EN671-1 LPC approved or BSI approval. The hose reel shall have a 30 meters long of 25 mm. internal diameter reinforced non kinking rubber hose capable of withstanding a working pressure of 12 bar.

The hose reel shall turn on automatically when 1.5 - 1.8 meters of hose is withdrawn from the real.

The hose reel shall be equipped with ball valve as mentioned in the specifications , if the pressure more than 5 bar at hose reel inlet a pressure reducing valve shall be provided for the hose reel with no extra cost .

The hose nozzle shall be of chrome-plated brass, JET/ SPRAY/ SHUT/ OFF nozzle, and shall have 6mm orifice.

The cabinet shall be made stainless steel (316) construction of 1.5 mm thickness minimum labeled "FIRE HOSE REEL" and in Arabic, the fire hose cabinet shall be made by CNC machines.

One fire extinguisher shall be provided inside each cabinet.

The fire extinguisher shall be LPCB or BSI approved of the ABC type 6 kg capacity, as specified hereafter.

The fire hose cabinet shall be of dimensions sufficient to include the hose reel, the ball valve and pressure reducing valve and the fire extinguisher and to fit with the available space as shown on the Drawings.

5 PORTABLE FIRE EXTINGUISHERS

a. General

The fire extinguishers shall be of the rechargeable type and shall be supplied complete with the operating charge from the factory.

All portable fire extinguishers shall be mounted on special wall brackets that shall be supplied with the extinguishers from the factory. The brackets shall be specifically supplied for the extinguisher type and size concerned.

All portable fire extinguishers shall be LPCP or BSI0 approved

b. Type FE-1

Dry chemical fire extinguishers shall be of the ABC type with a rugged all-brass operating valve, large size operating lever, full vision pressure gauge, discharge hose and heavy duty drawn steel cylinder with hard, scratch resistant finish. The capacity shall be 6kg.

c. Type FE-2

Carbon dioxide fire extinguishers shall be of the pull-pin, squeeze-handle type with double braided hose, non-conducting discharge horn and heavy-duty drawn steel cylinder with hard, scratch resistant finish. The capacity shall be 4.5 kg.

d. Type FE-3

Automatic Fire extinguisher with sprinkler, located above burner of each boilers, BCF type, the capacity shall be 12 kg.

e. Type FE-4

Pressurized water fire extinguishers shall be of the air pressurized type with stainless steel finish. The capacity shall be 9 kg.

6 SIAMESE CONNECTION ASSEMBLY

Siamese connection assembly shall be installed for the use of Fire Brigade, as shown on the Drawings.

The Siamese connection assembly shall be gunmetal with two inlets. Each inlet shall consist of a 65 mm. instantaneous male coupling and a non-return valve and protected with a cap secured by a suitable length of chain.

The Siamese connection assembly shall be according to NFPA 24 and UL listed and FM approved.

The Siamese connection assembly shall include recessed stainless steel (304) cabinet with steel mesh glazed door, 2-way inlet breeching; drain valve, concrete support and other details. Horizontal inlet box with door fitted with Georgian wired glass panel marked "wet riser inlet" and spring cylinder lock with key.

The Siamese connection assembly shall have 100 mm. dia flanged outlet for attachment to the dry riser or wet main.

The Siamese connection assembly shall be located 760 mm. above ground level.

7 FIRE HYDRANT

Fire hydrant shall be constructed of cast iron castings complete with 100 mm dia. flange inlet and two 65 mm dia. valves with instantaneous outlets and with brass male couplings protected with cap secured by a suitable length of chain.

The fire hydrant shall be according to NFPA 24 and UL listed and FM approved.

The fire hydrant shall be sound construction and hydraulically tested to a pressure of 20.7 bar before being connected to the fire fighting network.

The fire hydrant shall be installed about 760 mm above ground level and finished with red color paint.

The fire hydrant shall be provided with an isolating valve installed underground complete with extension tube, operating key and cover.

A fire hose unit shall be installed to serve each fire hydrant, it shall comprise 65mm dia. textile fire hose 30 m long with male and female couplings, nozzle jet and spray with male coupling, and cabinet.

8 AUTOMATIC SPRINKLER SYSTEM

8.1 General Requirements

Sprinklers shall be installed as shown on the drawings and in accordance with the requirements of NFPA 13.

All sprinkles shall be from the same manufacturer.

Shop drawings prepared by the Contractor shall show the exact location, spacing and types of sprinklers.

All sprinklers shall be manufactured, tested and approved in accordance with the applicable standards of Underwriters Laboratories and Factory Mutual.

The following limitations and requirements shall be strictly followed:-

Nominal k-Factor shall be 5.6 (U.S) / 80.7 (metric)

Nominal Orifice Size shall be 12.7 mm with 15mm NPT THREAD TYPE.

Minimum Operating Pressure shall be 50 kN/m^2

Maximum Working Pressure shall be 1200 kN/m^2

- Type, spacing, and position of sprinklers shall be as specified here under.

- Sprinklers so located as to be subject to mechanical injury shall be protected with approved sprinkler guard.

- All sidewall sprinklers and ceiling mounted pendent sprinklers shall be provided with escutcheons plates of the same color as of the walls or ceiling on which the sprinklers are mounted.

- Sprinklers shall not be altered in any respect or have any type of ornamentation or coating applied after shipment from the place of sprinklers manufacturer.

- When painting the sprinkler piping or painting in areas near sprinklers, care shall be taken to avoid any coating applied to sprinklers.

- Any sprinklers that have been painted or coated except by the sprinklers manufacturer, or damaged shall be replaced with new approved sprinklers of the same characteristics. Cleaning of painted sprinklers, or repairing damaged sprinklers will not be permitted.

8.2 Spacing, Location, and Position of sprinklers

All sprinklers shall be located and spaced as shown on the Contract drawings and in compliance with NFPA 13 and civil defence regulations.

8.3 Sprinklers Specification

- All sprinklers shall be UL listed and FM approved.

- All sprinklers shall be of k-factor 5.6(80) unless otherwise specified, and manufactured of brass finish pattern, frame, and deflector, except for dry pendent type which shall have chrome plated components.

- Sprinkler shall be integrated with sensitive glass bulb operated at the required temperature rating. Fusible element will not be accepted.

- Unless otherwise indicated on the drawings, all sprinklers shall have a temperature rating 68 C (155 F) with bulb color Red.

- Corrosion - resistant coated sprinklers shall be installed where required.

- Sprinklers equipped with protection guards or shields shall be installed where required.

8.4 Sprinklers Types

A) Concealed Flush Type Pendent Sprinkler :

Pendent sprinklers designed to be installed in such a way the water stream is directed downwards again the deflector flush type.

Pendent sprinklers shall be installed with push-on plate.

Standard Pendent sprinklers shall be marked SSP and shall installed in Pendent position only.

B) Standard Upright Sprinklers:

Sprinklers designed 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.

Standard Upright sprinklers shall be marked SSU and shall installed in Upright position only.

C) Sidewall sprinklers:

Sprinklers having special deflectors that are designed to discharge most of the water away from the nearby wall in a pattern resembling one quarter of a sphere with a small portion of the discharge directed at the wall behind the sprinkler.
All sidewall sprinklers shall be of quick-response extended coverage type with special extended directional and discharge patterns.
Sidewall sprinklers shall be installed horizontally and marked with SIDEWALL-TOP.

D) Dry Pendent Sprinklers:
Sprinklers for use in a pendent position in cold storage rooms. Patten, frame and deflector shall be manufactured of chrome-plated finish.

Return bends shall not be installed for dry pendent sprinklers

E) Intermediate temperature classification sprinklers:

All Sprinkler under skylight shall be of the Intermediate temperature classification

All sprinklers shall be Standard Upright Sprinklers and shall be automatic sprinklers of the frangible bulb type and shall produce a hemispherical water distribution pattern below the deflector.

All sprinkler shall be intended for use in fire sprinkler systems designed based on NFPA 13.

Temperature rating shall be 79-107 ^{o}C

Nominal Temperature Rating shall be 93^{o}C

Glass Bulb Color shall be green and white frame color

8.5 Alarm Valves Assemblies

All alarm valves assemblies shall be UL listed and FM approved.

A) Alarm floor control valve assembly shall comprise:

- Grooved end butterfly valve equipped with tamper switch
- Water flow switch
- Test and drain valve complete with indication glass
- Drainage outlets
- Pressure gauge

B) Main alarm valve assembly shall comprise:

- Control check valve with motor gong
- Indicating grooved end type butterfly valve equipped with tamper switch
- Water flow switch
- Test connection
- Drainage outlets and tundish
- Pressure gauge

C) Deluge Alarm Valve assembly shall comprise:-

- Deluge system control panel with backup battery connected to the main fire alarm panel via fire alarm mode.
- Fire alarm modules from main fire alarm panel.
- Pressure alarm switch.
- Solenoid valve and electric actuation trim.
- Indicating grooved end butterfly valve equipped with tamper switch.
- Deluge alarm valve, which shall comprise:-
  1. Body assembly
  2. Clapper and arm assembly
  3. Auxiliary clapper assembly
  4. Clapper latch
- Water flow switch.
- Test connection.
- Drainage outlets and tundish.
- Pressure gauges.
- Air supply control valve
- Motor Gong

Water flow switch shall be so constructed and installed that any flow of water from a 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.

Tamper switch provided for the indicating better fly valve shall initiate an alarm when the indicating butterfly valve is moved from the normal position. A test connection not less than 50mm in diameter,

terminating in a smooth bore corrosion-resistant orifice to provide a flow equivalent to one sprinkler, shall be installed and be equipped with sight glass, drain valve and shutoff valve.

Test connections may be used for draining the system sections.

All alarm valve assemblies shall be provided with identification signs.

9 FIELD ACCEPTANCE TESTS AND MAINTENANCE

9.1 General Requirements

The Contractor shall perform all tests including but not necessarily limited to the following:

- Flushing Test
- Hydrostatic testing of pipe network
- Testing of alarm valves (for sprinkler system)
- Testing of sprinklers
- Testing of hose reels, fire hydrants and Siamese connection
- Maintenance inspection test

No part of any piping system shall be painted, covered or enclosed until it has been tested, inspected and accepted.
All tests shall be conducted in the presence of the Engineer, as directed by him and to his entire satisfaction.

The Contractor shall provide all labor, equipment, material, instruments, power and connections required to execute all testing, balancing and adjusting as directed.

All expense incurred by the testing shall be borne by the Contractor including the cost of repair or replacement of defective work, cost of restoring, repairing or replacing damaged work resulting from the tests and the cost of replacing defective or inadequate equipment and material all as directed by the Engineer.

9.2 Hydrostatic Testing of Pipe network

All piping systems including drainage piping shall be hydrostatically tested for ensuring complete tightness at not less than 16 bar pressure for 4 hours.

Systems can be tested as a whole or in sections to facilitate the progress of the work.

No part of any piping system shall be tested to a pressure less than the specified test pressure measured at the lowest point of the system.

Care shall be taken not to subject any equipment, apparatus or device to a pressure exceeding its prescribed test pressure as obtained from its name plate data or from manufacturer's published data. Pressure tests shall be applied before connecting piping to equipment. Relief valves, instruments, automatic air vents, and all devices that might be damaged by the test pressure shall be removed, disconnected or blanked off.

No pressure shall be applied against the closed gate of gate valves. All valves shall be in the open position but not completely back seated during testing. End valves shall be capped.

In testing flanged piping, temporary blank flanges shall be installed and firmly anchored to accommodate all developed end thrust.

All piping that can be damaged by end thrust developing from hydrostatic testing shall be properly anchored during testing especially at changes of direction.

The piping system to be tested shall be closed by plugging and blanking all openings in the system and filled slowly with water making sure to vent all entrapped air. Plugs shall be released temporarily to ensure that water has reached all parts of the system.

Pressure shall be applied to the system by means of a hand pump drawing from a water container.

The pump discharge shall be connected to the system through a globe valve, check valve and recently calibrated pressure gauge of suitable range to have the test pressure read in the middle of the range.

After the test pressure is reached, the pump shall be blocked off by closing the globe valve and the variations of pressure in the system monitored on the pressure gauge.

While the system is under pressure, a careful inspection shall be made of all pipes and joints and if any leaks in joints or evidence of defective pipe or fitting is disclosed the defective work shall be corrected immediately by replacing defective parts with new joints and materials. No make shift repairs or application of any repair compound will be permitted.

After the correction is made the pressure test shall be repeated until a completely tight system is ensured.

The test pressure shall be released slowly so as not to produce shocks and sudden contraction that might damage the piping.

9.3 Flushing Test

- All provisions shall be made to properly drain all parts of the system. Flushing test shall be performed for the fire fighting system.
- Flushing of each main pipe supplying branch lines of sprinkler system shall be made through the test connection installed at each alarm valve assembly and other test connections installed.
- Flushing of the risers shall be made through the hose reels.
- Additional drain connections shall be provided, where needed to perform the flushing test for all parts of the fire fighting system.

  In any case if lines become plugged during the flushing test or flow test, piping must be dismantled and cleaned.

9.4 Test of Alarm Valves (For Sprinkler System)

- Flow switches shall be tested by opening the test connections installed at the alarm valve assemblies and the other test connections installed.

  The water flow shall be observed through use of the installed sight glass and the pressure shall be read from the installed pressure gauges.

  Water flow detecting devices including the associated alarm circuits and alarm signals located in the central control panel shall be tested by an actual water flow through use of the test connection.

- Tamper switches mounted on the indicating valves including the associated alarm circuits and alarm signal located in the central control panel shall be tested by playing with the indicating valve.

9.5 Test of sprinklers

Operating test of automatic sprinklers shall be performed in accordance with Civil Defense Department instructions and requirements.

All automatic sprinklers shall be replaced when the representative samples fail to meet test requirements.

9.6 Maintenance

The Contractor shall perform during maintenance period all weekly, monthly quarterly and annual inspections test and maintenance for the sprinkler system, in accordance with the requirements of NFPA 13 A. Records shall be maintained on all work performed.
The Contractor shall submit to the Owner an original edition of NFPA 13 A standards.

10 FIRE FIGHTING PUMPING UNIT (PACKAGED PUMPSET) (FFP-1)

The booster pump set shall be completely automatic and skid mounted unit assembled. The pumps installed on the pump set shall be approved by WRAS.

The pump manufacturer shall have been in the business of manufacturing complete pumping systems for minimum of 10 years.

Pump set shall include the following features:-

1. Two Vertical multi-stage pumps with high efficiency motors and drives, quantities as shown on drawings for each set.
2. Skid plate shall be heavy duty epoxy painted equipped with vibration absorber.
3. Copper or stainless steel suction and delivery manifolds with flanged connections.
4. Copper ball isolating valves and flexible connections on suction and delivery for each pump.
5. Check valves on delivery for each pump.
6. Strainer on suction on the main connection pipe for the pump header.

7. Pressure gauge at discharge manifold, electrical pressure switch and pressure relief valve.
8. Control panel.
9. Pressure vessel on discharge manifold as recommended by the pump manufacturer.
10. Weather resistance painted Heavy-duty steel metal louvered box with door.

The pumps impellers, guide vanes, shafts and outer sleeves shall be stainless steel.

The pump motor shall be squirrel cage induction type and rated for continuous operation at ambient temperature not less than 50°C.

The motors shall be totally enclosed fan cooled type with insulation class (F) and IP54 protection and rated for 400 volt, 3-phase and 50 cycle.

The control panel shall be constructed of 1.5 mm thickness sheet steel and IP65 protection.

The control panel shall include all features and components shown in the drawings.

The sequence of operation described in the drawings shall be tested at the completion of the works.

QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of all pumps types, sizes and capacities required, whose products have been in satisfactory use in similar service for not less than 10 years.

B. The Agent or Authorized Dealer should be representing directly the manufacturer, a formal letter should be issued in the name of the Agent or Authorized Dealer directly from the manufacturer.

C. The Agent or Authorized Dealer should be registered in Jordan for not less than 5 years, and should have experience in selling, installing and maintaining pumps systems in Jordan.

D. Guarantee: **The pump set shall be the latest and newest model and latest technology for the manufacturer products** and shall include a (2) two years full guarantee, full warranty and full preventive maintenance on all parts and labor after acceptance by the Engineer and the owner including regular visits two times a year and upon request (cost of spare parts ,labor and regular visits and upon request deemed to be included in the contractor's cost for the two years after acceptance) .

11 FM - 200 SYSTEM

A. Description

FM-200 system shall be provided for the protection of the areas as shown on the drawings.

The system layouts and components shall be as shown on the Contract drawings and as specified hereafter.

The system shall comprise the following:-

- Cylinder and valve assembly
- Cylinder actuating controls
- Cylinder pressure supervisory switch
- Pressure switch
- Pressure trip & fire curtains (if required)
- Nozzles
- Pipework, tubing and fittings
- Detection, actuation and control system
- All wiring, conduits and accessories

The work shall also include all provisions required to put the system in good operating conditions.

B. General Requirements

The system shall be designed, installed and tested to meet the requirements of NFPA-2001-1994.

All system components shall be UL listed and FM approved and accepted by Civil Defense Department.

All system components shall be supplied from one suppliers.

The Contractor shall furnish the following:-

- Warning and instruction signs at entrance to and inside such areas to inform persons or entering the protected area that FM-200 system is installed and any additional instructions or information may be necessary.

- All doors of the protected areas shall be sealed and equipped with self-closing devices to maintain the doors always in the closed position.

- Where the protected areas have a suspended false ceiling, care shall be taken to ensure tightens of false ceiling tiles, damaged false ceiling tiles shall be replaced.

C. Shop Drawings

Shop drawings of the FM-200 system shall be submitted to the Engineer for approval, prior to shipment of all equipment and components form the factory.

The shop drawings shall include but not necessarily limited to the following:-

- System layout in plan, sections, elevations, and isometric showing piping sizes, nozzles sizes, distance of each pipe section, cylinder mounting details, piping supports locations, detection and operating devices, control equipment and auxiliary equipment locations.

- Detailed wiring diagrams

- Certified characteristics curves of the nozzles showing the flow operating pressure and size of the nozzles.

- Certified computerized design and calculations of the FM-200, which shall be prepared by the supplier.

- Installation, operation and maintenance instruction manuals.

D. Cylinder and Valve Assembly

1. Cylinder

The cylinder shall be designed, fabricated, inspected and stamped in accordance with section VIII of the ASME-Unfired Pressure Vessel Code".

The cylinder design pressure shall be suitable for the maximum pressure developed at 130 F (55 C).

The cylinder shall be charged to a filling density not more than 70 lb/Ft3 (1121 kg/m3) and super pressurized with dry nitrogen to 360 psig (25.84 bars) at 70 F.

Each cylinder shall have nameplate specifying the agent, tare, gross weight and pressure.

The cylinder shall be mounted vertically either on the floor against a wall, or on a wall off the floor depending on the location conditions.

Each cylinder shall provided from the factory with adequate bracket assemblies such as bracket base, cylinder strap, valve hold

All cylinder bracketing shall be securely fastened to a wall or floor with bolts or lag screws.
The cylinder must always be securely bracketed before removing the anti-recoil plug fitted with cylinder valve, and attaching any pipe to the valve.

Each cylinder shall be equipped from the factory with a discharge valve capable of discharging liquid agent at the required flow rate.

The cylinder and valve assembly shall be shipped with an anti-recoil plug in the valve outlet.

The anti-recoil plug must remain in the valve outlet until the discharge dipping is connected to the valve.

2. Cylinder Valve

Cylinder valve shall be of high flow rate design to provide the rapid discharge time.
The valve shall be of the pressure seated type and has a brass, brass body, brass piston with seal, a pressure-releasing pilot check assembly for manual actuation, a safety disk assembly and a pressure gauge.

The valve shall be equipped with hand lever, and pull out locking pin for local manual mechanical control.

The cylinder valve shall have a connection port with built-in check valve for the connection of electric solenoid valve for electric actuation.

E. Cylinder Actuating Controls

1. Local Manual Mechanical Control

The cylinder valve is actuated by moving the actuator lever through 90 degree, which causes the pin to depress and open the pilot check on the cylinder valve. This action releases the pressure above the piston allowing the cylinder valve to open fully, and permitting agent to discharge through the outlet.

The locking pin shall be inserted in the control lever and body and secured with lead seal and wire to maintain the lever in the set position.

The lever shall be marked with arrow and the word "SET".

2. Electric Solenoid

The solenoid valve shall be normally closed and shall open when electric energy is applied, thus relieving the pressure above the cylinder valve piston causing the cylinder valve to open and permitting agent to discharge through the outlet.

The solenoid valve shall be fitted a swivel nut for mechanical connection and removal from the cylinder valve.
The solenoid valve shall be furnished with minimum 60 cm wire leads and ½" diameter conduit connection for electrical connection to the detection release.

F. Cylinder Pressure Supervisory Switch

This switch shall be used to provide a trouble signal if the pressure in the cylinder drops to approximately 220 psig.

The cylinder pressure supervisory switch shall be furnished as assembly with solenoid valve and swivel nut conductor.

The switch wiring shall not be connected to the solenoid operating circuit.

G. Pressure Switch

The pressure switch shall be used to perform interlock functions, sounding alarms and shutting down electrical motors of fans used for ventilation and air conditioning system in the protected areas.

The pressure switch shall be actuated only by the pressure of the extinguishing when discharged through the piping system, upon actual system discharge.

The connection between the discharge piping and the pressure switch shall be made with ¼" O.D. copper tubing and flared tubing fittings including reducing coupling, nipple and union for pressure switch connection, limitation of thing length shall be as recommended by the manufacturer.

The pressure switch shall have ½" male pipe thread and reset.

The pressure switch shall be located as closely as possible to the cylinder.

The pressure switch shall be furnished with fire leads and ½" diameter conduit connection for electrical connection to be alarm circuit and electrical fan motors.

The wire leads shall lead through 3/8" flexible steel conduit using suitable connectors at the pressure switch and at the junction box.

H. Pressure Trip

The pressure trip shall be used to release dampers or other weight or spring operated devices, such as fire curtains, which are normally open.

The pressure trip shall be actuated only by the pressure of the extinguishing when discharged through the piping system, upon actual system discharge.

The pressure trip shall be furnished with vents S-hook, stainless steel cable to be released, cable clamp, clearance holes, and mounting bolts or lag screws.

Limitation of the tubing length shall be as recommended by the manufacturer.

Automatic fire curtains shall be provided for each opening and louver where located in the protected area walls.

The fire curtains shall be spring operated type maintained at normally open position and must be closed to seal the protected area enclosure

to prevent the scope or dilution of the Agent extinguishing when discharged through piping system.

I. Nozzles

Nozzles shall be of corrosion-resistant material.

Nozzles shall be marked to identify the manufacturer, the type and the size.

All nozzles shall be provided with blow-off caps to protect nozzle orifices from the entrance of foreign matter.

Orifice size shall be selected to deliver the required flow rate at each nozzle.

Each nozzle installed in cabinets or panels shall be fitted with proper lock nut for locking the nozzle to the cabinet or panel.

All nozzles shall be installed in accordance with the limitations of their listings and approvals.

The exact nozzle location shall be determined before installation.

All nozzles must be installed vertically with the threaded end up.

Where nozzles are mounted on suspended false ceiling, proper chrome plated escutcheon shall be fitted and securely mounted on the ceiling.

All nozzles shall be of 360 degree type.

J. Pipe Work

1. Piping and Fittings

All distribution piping to nozzles shall be schedule 40 standard weight-ASTM-A-53 Grade B, black seamless steel pipes with threaded ends.

All pipe and fitting threads shall conform to ANSI B1.20.1.

All piping joints shall be made with approved pipe compound or Teflon tape.

All pipes and fittings shall be designed to have a working pressure not less than 620 psi.

Copper tubing used for the connection of auxiliary equipment such as pressure switch and pressure trip, it shall be Type "K" and have approved pressure rating.

Pipe sizes shall be selected to deliver the required flow rate at each nozzle.

Flow shall be calculated on the basis of an average cylinder pressure during discharge.

The percentage of agent in piping shall not exceed 80 percent of the charged weight.

The pressure at any nozzle shall not be lower than 50% of the average cylinder pressure during discharge.

No piping to a nozzle should be larger than the nozzle connecting size.

2. Piping Installation

Piping shall be installed in accordance with good commercial practice. Care shall be taken to avoid possible restrictions due to foreign matter, faulty fabrication or improper installation.

All pipe send shall be thoroughly reamed after Cutting.

Particular care shall be taken to fasten the pipe near each nozzle in order to prevent pipe movement due to the reactive force during discharge.

UL listed pipe hangers shall be used.

Dry air or nitrogen should be blown through the piping to remove chips or other debris prior to the installation of nozzles.

K. Detection, Actuation and Control Systems

1. General

Detection, actuation, alarm and control systems shall be installed, tested and maintained in accordance with NFPA 70, NFPA 72 and NFPA 72 E.
Automatic detection with automatic actuation shall be used.

Detection devices and alarm and control equipment shall be UL listed and FM approved.

Adequate and reliable primary and 24-hour minimum stand by source of energy shall be used to provide for operation of the detection, signaling, control and actuation requirements of the system.

Automatic detectors shall be of type capable of detecting and indicating smoke, flame and combustible vapors.

Actuation of the system shall be accomplished by detection using two separate detectors or zones of detectors or by more than one detector operating in sequence in order to prevent system actuation by a transient condition which may cause one detector to operate.

Control panel shall be furnished to supervise all actuating devices and wiring. The control panel shall be listed or approved for the number and type of actuating devices utilized.

2. Alarms and Indicators

The following alarms and indicators shall be provided in the control panel:-

- The operation of warning devices shall be continued after agent discharge until positive action has been taken to acknowledge the alarm and proceed with appropriate action.
- Visible alarm for failure of solenoid valve
- Visible alarm indication operation and failure of each supervised device, cylinder pressure supervisory switch, pressure switch, and pressure trip.
- Visible indication for primary power supply and failure
- Visible indication for emergency power supply and failure
- Any necessary alarm signal for proper operation.

Alarms indicating failure of supervised devices or equipment shall give prompt and positive indication of any failure and shall be distinctive from alarms indication operation or hazardous conditions.

In addition to the above alarms located at the control panel, a continuous alarm (audible and highly visual) shall be provided and located at suitable place near egress of the protected area to give warning of fire immediately upon detection of fire.

3. Remote Control of FM-200 System

Visual alarms and indicators used to indicate the operation, hazards to personnel, and failure of supervisory devices shall be located at the central control panel, which is continuously supervised.

Audible and highly visible alarm shall be provided for warning of discharge immediately operated upon detection of fire.
Alarms shall also be provided for the primary and emergency power supply and failure.

L. Testing

FM-200 system shall be inspected and tested by qualified personnel to meet the requirements of NFPA 2001 - 1994.

The result of all tests shall be documented in report form and shall be submitted to the Engineer for approval.

All tests shall be carried out in the presence of Engineer, Owner representative, manufacturer representative, and the civil Defense Department Representative.
The following tests shall be performed:-

- Piping pressure test
- Functional test (Pre discharge)
- Operational test
- Testing of control panel
- Testing of remote controls
- Any additional test may be required by the Engineer
- Monitoring

M. Maintenance

The contractor shall perform during maintenance period all annual and semiannual inspection, tests and maintenance for the system in accordance with the requirements of NFPA 2001 - 1994.

The contractor shall also perform all preventive periodic maintenance requirements as recommended by the manufacturer instructions.

Records shall be maintained on all work performed.

The contractor shall submit to the Owner an original edition of NFPA 2001-1994, and the operation and instructions mauls as recommended by the manufacturer.

12 GAS LEAK DETECTION SYSTEM

General

Gas Leak detection, actuation, alarm and control systems shall be installed, tested and maintained in accordance with NFPA 70, NFPA 72 - 72 E.

The Gas leak detection system shall be provided for the protection against gas leaks in fire hazard areas such as kitchen areas, gas shutter and as shown on the drawings.

Adequate and reliable primary and 24-hour minimum stand by source of energy as back up batteries shall be used to provide for operation of the detection, signaling, control and actuation requirements of the system.

Automatic detectors shall be of type capable of detecting and indicating the LPG combustible vapors.

Actuation of the system shall be accomplished by detection using two separate detectors or zones of detectors or by more than one detector operating in sequence in order to prevent system actuation by a transient condition which may cause one detector to operate.

Control panel shall be furnished to supervise all actuating devices and wiring. The control panel shall be listed or approved for the number and type of actuating devices utilized.

The Control panel shall be of multiple channels capable of accepting 12 sensor housings and collecting heads,and each control panel shall have two extra sensor housing (control module) and collecting heads.

The system layouts and components shall be as shown on the Contract drawings and as specified hereafter.

The work shall also include all provisions required to put the system in good operating conditions.

All system components shall be UL listed and FM approved and accepted by Civil Defense Department.

All system components shall be supplied from one supplier.

The gas leak detection system shall consist of a control module and detection head, which are connected together to indicate gas concentration and alarm output.

The detector shall provide an electrical signal, which changes when gas is detected. This shall be monitored by the control module and shall be displayed on a local panel mounted meter.

An individual meter shall be provided for each control module sealed in units appropriate to gas range being measured.

The control module shall process the input signal from detector and display the measured value on front panel meter and compares with the set value and in the event of any variation, the control panel indicators shall send both audio and visual alarms to show the alarm level has been exceeded.

Alarm Relays Volt free contact shall also be available for connecting to central alarm control panel and building management system for fault condition printout on management work station. The detectors and control cables shall be installed at higher levels of the gas pipes for effective sensing in the event of any leakages.

A. Detection and Control Systems

Alarms and Indicators

The following alarms and indicators shall be provided in the control panel:-

- The operation of warning devices shall be continued after gas detection until positive action has been taken to acknowledge the alarm and proceed with appropriate action.
- Visible alarm for failure of solenoid valve
- Visible alarm indication operation and failure of each supervised device, and solenoid valve.
- Visible indication for primary power supply and failure
- Visible indication for emergency power supply and failure

- Any necessary alarm signal for proper operation.

Alarms indicating failure of supervised devices or equipment shall give prompt and positive indication of any failure and shall be distinctive from alarms indication operation or hazardous conditions.

In addition to the above alarms located at the control panel, a continuous alarm (audible and highly visual) shall be provided and located at suitable place near egress of the protected area to give warning of fire immediately upon detection of gas.

B. Testing

Gas Leak system shall be inspected and tested by qualified personnel to meet the requirements of NFPA 2001 - 1994.

The result of all tests shall be documented in report form and shall be submitted to the Engineer for approval.

All tests shall be carried out in the presence of Engineer, Owner representative, manufacturer representative, and the civil Defense Department Representative.

The following tests shall be performed:-

- Functional test
- Operational test
- Testing of control panel
- Testing of remote controls
- Any additional test may be required by the Engineer
- Monitoring

C. Maintenance

The contractor shall perform during maintenance period all annual and semiannual inspection, tests and maintenance for the system in accordance with the requirements of NFPA 2001 - 1994.

The contractor shall also perform all preventive periodic maintenance requirements as recommended by the manufacturer instructions.

Records shall be maintained on all work performed.

The contractor shall submit to the Owner a copy of NFPA 2001-1994, and the operation and instructions mauls as recommended by the manufacturer.

END OF SECTION 15520