Electrical Works
Technical Specifications

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Jerusalem Design Center
M.Sharif

Index

SECTION-16000
ELECTRICAL WORKS

PART 1 - GENERAL

ELECTRICAL SUB-CONTRACTOR

A. The electrical work shall be carried out by an electrical sub-contractor who is on the approved list of electrical contractor's.

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

C. The name of the electrical sub-contractor, details of his experience and his staff qualifications and experience shall be submitted by the tenderer with his tender in accordance with form shown hereinafter which shall be filled by the tenderer and his proposed sub-contractor.

1.01 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. Additionally all equipment and installation shall conform to local authorities Specifications.

Any Works whether or not shown on the Drawings and/or described in the Specifications but which can reasonably be inferred as necessary for the completion and proper operation of the works will also form part of the extent of the Contract

B. All Electrical Works complete in all respects shall be provided in accordance with the requirements of the Contract Documents. The scope of works shall include, but not be limited to the following:

1.02 A. RELATED SECTIONS

<u>SECTION</u>	<u>Title</u>
14200	Conveiance System
16000	Electrical Works
16010	General Provisions for Electrical Work
16110	Raceways
16120	Conduits
16200	Cables and Wires
16300	Supporting Devices
16400	Main Distribution Equipment
16500	Lighting
16640	Earthing
16670	Lightning Protection system
16720	Fire Detection and Alarm System
16760	Data System
16771	Public Address /Evacuation System
16772	Audio Visual, Conference, Interpretation System
16960	Building Surveillance System (CCTV)

B. <u>RELATED WORKS SPECIFIED ELSEWHERE</u>

The following related service installations are specified in other divisions of the Specifications. The Contractor shall co-ordinate all his installation with the related works such as:

- Plumbing
- HVAC
- Fire Fighting
- Interior Finishes & Architectural Works
- Any other sub-contractor engaged for the project.

1.03 REGULATIONS

A. <u>Authorities and Regulations</u>

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.

1.04 CLIMATIC CONDITIONS

A. Extremes of temperature and humidity are experienced. Periods of high humidity has been recorded.

Sand and dust storms occur and even on comparatively still days, fine dust is carried in the atmosphere.

B. All equipment and materials forming the electrical installation work shall be designed and constructed to provide satisfactory service without any harmful effects for prolonged and continuous use in the climate of the project Generally, the following temperatures shall be made as design criteria:

1. 35 Deg. C if installed within buildings having good heat insulating properties and adequate ventilation.

2. 40 Deg.C if installed in well ventilated positions and shaded from direct sunlight throughout the day.

3. 45 Deg.C if exposed to direct sunlight.

C. ***Minimum Temperatures Likely to Occur are:***

1. -5 Deg.C outdoors.

2. 10 Deg.C indoor.

D. The above temperatures do not take into consideration heat generated from the equipment itself or from any other equipment installed in the vicinity.

E. The capacity and rating of all electrical equipment and materials given are Local rating, i.e. rating when equipment are operating under Local Climatic Conditions. Any derating factors applied should be clearly indicated.

F. Where specific sizes are indicated e.g. cable sizes, due allowances have been made in the design for the climatic conditions of project and de-rating has been applied.

1.05 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: -

Voltage	415 Volts $\pm$ 6% 3Phase 4-Wire
Frequency	50 Hz $\pm$ 4%
Neutral	Solidly Earthed
Fault Level	31 MVA at 415 volts
Fault Duration	0.5 Seconds

1.06 STANDARDS

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 Electrotechnical Commission (I.E.C.) and if this is not available then with the latest relevant British Standard Specification (B.S.S.) or other approved National Standards. Specifically the following standards/regulations/codes shall be acceptable:

- IES/CIBSE Illumination codes
- CIE International Commission on Illumination
- Relevant British Standard Codes for Practice (BSCP)

- 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
- British Fire Officer's Committee (FOC) Rules (Latest Edition)
- National Fire Protection Association (NFPA)

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 these 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 Tenderer 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).

E. The term "materials" as used in this Specification refers to any basic engineering equipment which forms part of the installation but which in itself does not form a unit which can be specified with an output performance.

F. Materials are related to a Standard whenever applicable and it is deemed that such reference, without further amplification, includes the whole of the current Standard. With the approval of the Engineer, alternative and equivalent National or International Standards may be used, but these must be declared and agreed at the time of Tendering.

G. All materials/equipments/light fittings manufacturers selected by the contractor shall have established local agents.

1.07 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.

1.08 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.

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.

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.

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.

1.09 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.

1.10 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.

1.11 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. so as 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. ***<u>Shop Drawings</u>***

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, 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. 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.

D. *Progress Drawings*

1. Furnish and keep on the job site at all times, one complete and separate set of blackline 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 colouring in the various parts of the Works as they are erected.

E. *Record Drawings / As Built Drawings*

1. At the conclusion of work, prepare and submit "Record Drawings" (As Built Drawings).

2. These drawings shall be titled "Record Drawings" and shall be prepared from the marked up progress prints. Submit "Record Drawings" to the Engineer for review and approval.

3. Should there be any difference between the final "Record Drawings" and the Contract Drawings, then arrange for obtaining approval of the final "Record Drawings" from the local authorities.

4. 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.

1.12 DISCREPANCIES

A. Before signing the contract, the Contractor should verify for himself any discrepancies between B.O.Q and the drawings. He may add in his offer any additional amounts that are required to meet the discrepancies. Under No circumstances he will be eligible for additional claims on account of such discrepancies

PART 2 – PRODUCT

2.01 MATERIALS

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

B. Unless otherwise specified, all equipment and materials shall comply as a minimum with the latest relevant recommendations of the International Electrotechnical 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 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 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 to the Specification.
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. Manufacturers specified by name are not relieved of the responsibility for meeting Specification requirements and submittal for approval.

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.

PART 3 – EXECUTION

3.01 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 these 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.

3.02 CONTRACTOR'S REPRESENTATIVE, STAFF AND WORKMEN

A. The Contractor shall keep permanently on the site, a competent Senior Electrical Engineer, having an experience of not less than 10 years, as his representative fully experienced and who has executed as Superintendent of electrical installation works of the type and scale similar or larger than this Project.

B. The Contractor shall submit to the Engineer the Schedule of Proposed Contractor's Engineers Senior Draftsmen and Senior Foremen employed for this Project stating the names, nationalities, ages, qualifications and detailed experience before proceeding with the Works. The Contractor shall from time to time supply any further personnel in addition to those proposed and approved as may be necessary to ensure the satisfactory progress of the works.

3.03 IDENTIFICATION AND LABELLING

A. The components of all main and sub-main switch boards, 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. "Traffolite" 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.

3.04 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 in accordance with the requirements of Section 'E' of the IEE 'Regulations for Electrical Equipment of Buildings’ 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 equal or better than the requirements of the IEE and the local authorities regulations and these shall be recorded on forms similar to the ones described in the IEE regulations.

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 's final approval microfilm of as-built drawing shall be given to the Engineer for permanent record.

I. An amount equal to 5% of the contract value for the Electrical, Communication and Electronic works will be retained till the completion of all commissioning. This amount is in addition to the 10% retention money, which will be release after the completion of 2 years of maintenance contract.

3.05 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.

3.06 OPERATION AND MAINTENANCE DURING TWO YEAR MAINTENANCE PERIOD

A. Include for Operation and Maintenance including Preventive Maintenance during the two (2) year 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 personnels 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. 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.

3.07 GUARANTEE

A. Manufacturer's 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.

3.08 SPARE PARTS

A. **Spare Parts during Two years Maintenance Period:**
Contractor shall provide all spare parts required during the two (2) years maintenance period at NO cost

B. In special cases the spares have been listed in the sections. In all other cases manufacturer's recommened spares shall be provided.

***** END OF SECTION *****

Section 16010
General Provisions for Electrical Work

Part 1-General

1.01 Work Included

All electrical work shown on the drawings or mentioned in B.O.Q.

1.02 Quality Assurance

A. General Provisions contained in this section, shall apply and form a part of each and every section of specification, Division 16, Electrical.

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

C. 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 Electrotechnical Commission.
2. BS British Standards.
3. ISO International Standards Organization.
4. VDE Association of German Electrical Engineers.
5. IES Illuminating Engineering Society.
6. Municipality Regulations.
7. Regulations and instructions of Civil Defense Department.

D. 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.

E. All items of labor and material required to comply 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.

F. 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.

G. The General arrangement of circuiting and equipment shall be as shown on the drawings. Detailed drawings and proposed deviations due to actual field conditions or other causes shall be submitted to the Supervising Engineer for review. The Contractor shall carefully examine all drawings and shall be responsible for the proper fitting of materials and equipment in each location as indicated, without substantial alterations. The Contractor shall carefully investigate the structural and finish conditions affecting his work and shall arrange such work accordingly, furnishing such fittings and accessories as may be required to meet such conditions.

H. 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.

1.03 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 Division 16, Electrical. 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.

Material Submittals: Shall be made for 3 different manufacturers. Energy saving equipment /materials shall be given preference.

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.

1.04 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.

1.05 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.

1.06 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.

1.07 Quality of Equipment

Quality shall be of the best grade for each type or class, even through 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, warpage, or their defects. Energy consuming equipment shall be of the energy saving type, wherever relevant and applicable.

1.08 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.
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.

B. 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.

1.09 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.

1.10 Metering

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

1.11 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).

1.12 Electrical Utilities

A. Power supply to the site will be at 400 Volts, 3 phase, 50Hz. The interface with the utility company incoming supply is the KWH meter.

B. The Contractor shall make his interface with the incoming primary telecommunications cable(s) at the site boundary in the manner shown on the Drawings.

Part 2 Products

2.01 General

A. Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various sections of the specification, Division 16, Electrical.

Part 3 Execution

3.01 Workmanship

Materials, products and equipment furnished by the Contractor, shall be installed and all work shall be performed in a first-class workmanlike 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.

3.02 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 150mm 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 100mm 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.

3.03 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. The 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.

3.04 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.

3.05 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.

3.06 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 colour.

3.07 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 ungalvanized 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.

3.08 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 Division 16 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.

3.09 Equipment Connections and Motor Starters

A. In addition to electrical work, the Contractor shall make all electrical connections to mechanical and medical equipment furnished under other sections i.e. the Plumbing, Heating, Air Conditioning and Ventilation Sections of Division 15.

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, overcurrent 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 overcurrent in accordance with their rated ampecities. An overcurrent 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. Show transformer full load and 150, 400, or 600 percent currents, transformer magnetizing inrush, ANSI transformer withstand parameters, magnetic in rush current point and significant symmetrical and asymmetrical fault currents. Terminate device characteristic curves at a point reflecting the maximum symmetrical or asymmetrical fault current to which the device is exposed.

H. Select each primary protective device required for a delta-star connected transformer so that its characteristics or operating band is within the transformers characteristics. Where the primary device characteristic is not within the transformer characteristics, show a transformer damage curve. Separate transformer primary protective device characteristics by a percent current margin to provide proper coordination and protection in the event of secondary line-to-line faults. Separate medium voltage relay characteristic curves from curves for other devices by at least 0.4 second time margin.

I. In each brochure, include complete sets of individual protective device time-current characteristics on transparencies.

J. 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.

K. The plans and specifications indicate the general requirements for the electrical equipment being provided under this contract. Changes and additions to equipment characteristics may be suggested by the results of the short circuit and protective device coordination studies. Submit any such proposed changes and additions as a part of the study brochure material. Necessary field settings of devices, and adjustments and minor medications to equipment to accomplish conformance with the approved short circuit and protective device coordination studies shall be carried out by the particular manufacturer or by the Contractor at no additional cost to the Owner.

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-16075
ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical identification to identify all electrical items for easy operation and maintenance including, but not limited to the following:

1. Nameplates and labels.
2. Wire markers.
3. Colour coding of raceways.
4. Circuit identification charts.
5. Cable identification tags.
6. Cable warning tapes.
7. Cable markers.
8. Equipment warning/danger signs.

1.02 RELATED SECTIONS

A. Section 09900 Painting.
B. Section 16050 Electrical Wiring, General.

1.03 REFERENCES

IEC 364	Electrical Installations
BS 7671	Electrical Wiring Regulation (IEE 16th)
IEC 391	Marking of Insulated Conductors
IEC 445	Equipment Terminals (Identification of Equipment Terminals and Terminations of Certain Designated Conductors).
IEC 446	Identification of Bare Conductors by Colors or Numerals.

1.04 SUBMITTALS

A. Submit for complete and detailed manufacturer's catalogues and data relating which shall include, but not limited to, the following:

1. Name of the manufacturer.
2. Country of origin.
3. Method of obtaining spare parts for maintenance and list of spare parts sufficient for a 2 years period.
4. Technical performance of the equipment selected.
5. Dimensional details needed for installation and maintenance.
6. Delivery time from the date of orders.

7. Copies of test reports or certificates.

8. Control schematics and wiring diagrams.

B. Provide samples of proposed devices together with the above submittal for approval of the Engineer.

C. Manufacturer’s Instructions: Indicate application conditions and limitations of use stipulated by product Testing Agency and include instructions for storage, handling, protection, examination, preparation and installation of the product.

1.05 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of items the types, sizes and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years. Preference shall be given to local manufacturers and agents/suppliers.

B. Installer: Firms regularly engaged and qualified with at least 5 years of successful installation experience on projects with electrical installation work similar to that required for the project.

C. All items of Electrical Identification shall be comply with the requirements of BS and Local Standards Organization.

PART 2 PRODUCTS

2.01 NAMEPLATES AND LABELS

A. Nameplates and labels shall be engraved on a three-layer 2 traffolyte plate having minimum thickness of 2 mm, securely screwed to the housing and have black letters on white background in Arabic and English.

B. The name plates and labels shall be required for each electrical distribution board, control panels, equipment enclosures, substation equipment, disconnect switches and equipment cabinets.

C. Lettering shall be block capitals standing :

1. 6 mm high for identifying individual equipment and loads.

2. 10 mm high for identifying grouped equipment and loads.

D. Labels using embossed adhesive tape with 6mm white letters on black background or transparent adhesive tape with 6 mm black letters, as selected by the Engineer, shall be used for identification of individual wall switches, receptacles, low current outlets, speakers, control device stations, junction/pull boxes, electrical boxes and fittings, etc.

2.02 WIRE MARKERS

A. Wire markers shall be split sleeve or tubing type.

B. The wire markers shall be required for each conductor at panelboard gutters, pull boxes, outlets, junction boxes and each load connection.

C. All power and lighting circuits, branch or feeder circuits and control circuits shall require wire markers.

2.03 COLOUR CODING OF RACEWAYS

A. Provide color bands with printed description of each system, minimum 75 mm wide for all cable trays/ladders and trunking runs. These color bands shall be applied at each electrical distribution/panel board, low current system control panels and junction box locations and at 15 m centers within an area.

B. Provide color bands with printed description of each system, minimum 25 mm wide for conduits up to 25 mm in diameter and one-half the conduit diameter for larger conduits, applied at panel and pull box locations, within each room, and at 6 m centers within an area.

C. Following color banding shall be used for the raceways of various electrical systems, however subject to final decision of the Engineer. Color bands for the electrical systems not described here shall be as agreed on site:

1. Lighting: gray.
2. Normal Power: brown.
3. Essential Power : black
4. Earthing : green.
5. Fire alarm : red.
6. Telephone : blue.
7. Sound : yellow.
8. Data : purple.
9. Television : rust.

2.04 CIRCUIT IDENTIFICATION CHARTS

A Individual circuit identification charts shall be provided for all panelboards, distribution boards, control panels, etc. giving following information as a minimum.

1. Circuit numbers
2. Phase
3. Load names with location.

4. Connected load.
5. Outgoing terminal numbers.
6. Sizes and types of protective devices.
7. Sizes and types of incoming and outgoing cables.
8. Contacts location references of relays and other control devices (if any).

B. Charts shall be typed on A4 size sheets. They shall be enclosed in a clear plastic envelope and shall be securely fixed to the inside cover of the unit. Additional copies of the charts shall be included in the Operation and Maintenance Manuals.

2.05 CABLE IDENTIFICATION TAGS

A. All cables which exit from manholes, vaults, handholes, and transformer or switch enclosures shall be properly tagged or labeled. Tags shall be permanent, non-corrodible and clearly readable. Tags should include the information listed below for the various circuit categories:
Primary Cables - 11 kV
Feeder Name
Voltage
Phase (for single conductor cables)

B. Cable identification tags for wire and cable circuits shall be of an opaque nylon material arranged to include a marker plate, non-releasing nylon ties, and cable fastening tail. One side shall be roughened to hold black nylon permanent ink. Identification shall be permanent and waterproof. The holding device shall be designed to allow the fastening tail to pass around the cable through the holding device, and prevent removal of the tail without cutting it loose from the marker. Cable identification shall be inscribed in Arabic and English.

2.06 CABLE WARNING TAPES

A. For buried LV and HV cables use warning tapes according to the standard practice of Electricity Supply Authority and applicable international standards.

B. Cable warning tapes shall be of polythene, not less than 150 mm wide and at least 0.25 mm thick. They shall be yellow in color for LV and MV cables and bear the continuously repeated legend – "CAUTION ELECTRIC CABLE BELOW" or similar in English and Arabic, in black letters not less than 30 mm high.

C. For buried low current/communication cables or duct banks, use warning tapes as per the standard practice of Local Telecom Supplier and applicable international standards.

2.07 CABLE MARKERS

A. Buried cables shall be permanently identified by concrete markers. The markers shall be 600 mm square x 100 mm thick with impressed character; they shall be made of grade 20 concrete, with 10 mm aggregate. The impressed characters shall be in English and Arabic and worded "HV CABLE" or "LV CABLE" as appropriate together with circuit details as required for proper identification. In addition, the word “JOINT” shall be added to above words, where applicable.

B. Except where cables are buried, located in switchrooms, in ducts and spaces designated solely for electrical services, or have orange oversheaths; they shall be identified by adhesive bands colored orange, complying with standards and codes of practice mentioned elsewhere in the Specifications. The bands shall be not less than 100 mm long, located at least once within each separate compartment through which cables pass and at intervals not exceeding 12 m.

C. Except where cables are buried or enclosed in conduit, trunking or ducting; they shall be permanently identified by discs. The discs shall be of laminated plastic materials with black character on white; character shall be not less than 3 mm high. The inscription shall indicate the nominal voltage, the designation of the load, the number and cross sectional area of cores and the rated voltage of the cable.

D. Cables identification discs shall be attached to the cables with ties. Disc shall be located within 500 mm of terminations and joints, at least once within each separate compartment through which the cable passes, and at intervals not exceeding 24 m, they shall coincide with the colour bands.

2.08 EQUIPMENT WARNING/DANGER SIGNS

A. For external use, pressure sensitive danger signs shall be used. Dimensions shall be as approved by the Engineer. The signs shall be heavy duty vinyl with a self-adhesive backing which can be applied to curved or irregular surfaces. Danger signs shall be weather-resistant and shall not discolor or deteriorate with age.

B. Danger signs shall be inscribed with the equipment voltage level along with an internationally recognized danger sign.

C. Warning/Danger signs made of red plastic (vinyl) with white letters at least 25 mm high reading "DANGER High Voltage" shall be fixed to the entrance doors of all 11 kV switchgear and transformer rooms.

D. Warning/Danger signs made of red plastic (vinyl) with white letters at least 15 mm high reading "DANGER 380V"or “DANGER 220V” as appropriate, shall be fixed to the lids, covers or doors of any equipment which contains terminals or conductors connected to more than one phase of a low voltage supply.

E. All signs shall be in English and Arabic.

2.09 LANGUAGE

A. The Arabic and English languages shall be used for all labeling and charts.

PART 3 EXECUTION

3.01 PREPARATION

A. De-grease and clean surfaces to receive nameplates and labels.

3.02 INSTALLATION

A. Install warning and descriptive labels as follows :

1. Metallic surfaces using stainless steel or chromium plated bolts and/or self tapping screws.
2. Concrete surfaces or masonry walls using and brass wood screws.
3. Timber surfaces using minimum 6 mm countersunk brass screws.
4. All insulated enclosures using an approved plastic welding adhesive.

B. The danger sign and identification number shall be affixed to the front or access doors of all transformers and switches. For equipment with two doors the danger sign shall be mounted on the left door with the identification number mounted on the right door. Both the danger sign and the identification number shall be centered 300 mm below the top edge of the doors and on the vertical centerline of each door.

C. On equipment with only one access door, the danger sign and the identification number shall be centered on the vertical centerline of the door, with the horizontal centreline of the danger sign 300 mm below the top edge of the door and the horizontal centreline of the identification number 250 mm below the danger sign centerline.

D. Locate cable markers at every point where cable(s) enter a building, sub-station, distribution/feeder pillar; at each joint, change of direction, road/pathway crossing, etc. Cable markers shall also be provided along the straight runs (route) of the cable(s) at the interval not exceeding 30 m.

***** END OF SECTION *****

SECTION 16110
RACEWAYS

PART 1 - GENERAL

1.01 GENERAL

A. Raceways shall include all bus ducts, 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 unless specifically indicated otherwise as per Specifications of local authorities : Non-Metallic Cable Trunking

C. In general, the raceways shall conform to the following specifications :
local authorities: Steel Cable Trunking
local authorities: Cable Trays & Racks

1.02 RELATED WORKS SPECIFIED ELSEWHERE

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

1.03 SIZE SELECTION

The size of the raceways shall be selected according to local authorities 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

2.01 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 1.6mm for trays upto 300mm and 2mm 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 and cable tray finished to G.D.C.D. standard 23rd March 1979. 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.

2.02 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 1.0m. 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.

2.03 CABLE LADDERS

A. Cable ladders shall be H-type made from 2mm mild steel with 3mm 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.

2.04 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.

The minimum thickness of metal employed in the construction of this trunking shall be 1.2mm and of the following thickness for various sizes :-

1.2mm thick - upto and including 100mm x 100mm

1.6mm thick - upto and including 150mm x 150mm

2.0mm thick - upto and including 230mm x 230mm

Adjoining sections of trunking shall butt tightly and shall be jointed 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.

2.05 OUTDOOR CABLE TRAYS

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

B. Assemble cable trays sunshaded cable trays 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 an 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 1.2m 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. Sun shade shall be supported at least 10cm above cable tray, and should have 2 side slope along the cable tray.

2.06 HANGER RODS

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

<u>PART 3 - EXECUTION</u>

3.01 GENERAL

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

3.02 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 100 Cms. All supports shall be galvanized.

- The trunking ends shall be properly closed.

- Earth continuity shall be provided at points through braided copper tape.

3.03 CABLE TRAYS

- Cable trays shall not sag more than 3 degrees between supports
- Cable trays shall be supported at not more than 100 Cms by galvanized wall brackets/supports or by stainless steel hanger rods.
- Cable trays shall not be cut through perforations

3.04 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.

3.05 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 – GENERAL

1.01 GENERAL

A. PVC conduits shall generally be allowed in CAST-IN-SITU. Surface installed Conduits (below or above false ceiling) shall be rigid steel (GI). Where heavy protection against mechanical damage is required only rigid steel (GI) conduit shall be used.

B All conduits and conduit fittings shall comply with concerned local authorities Specifications

C In precast concrete slabs etc. GI conduit shall be used

D All conduits are fire retardant colored for all systems even if used in concrete slabs.

1.02 CONDUIT SYSTEM

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

For underground installation UPVC conduit 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 authoritiesas similarly applicable to cable trays and Trunking.

1.03 RELATED WORKS SPECIFIED ELSEWHERE

C. Section 16200 Cables & Wires
D. Section 16300 Supporting Devices

1.04 QUALITY ASSURANCE

A. Relevant British Standards
B. Concerned local authorities rules and regulations
C. Alternative codes and standards which will satisfy the engineer that the material offered is of equal standard to that specified.

1.05 SUBMISSION

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

PART 2 - PRODUCTS

2.01 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 therefrom 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 not 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 fibre 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.

2.02 PVC CONDUITS

A. All rigid PVC conduit and conduit fittings shall conform to British Standard 4607 are to be certified as suitable for use at ambient temperatures upto 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.

All joints between conduits and fittings shall be watertight using vinyl cement recommended by the manufacturer of the conduit. A vinyl solvent shall be used for permanent joints and a cement of the type that shall remain in a sticky condition shall be used for expansion couplers.

A separate insulated earth wire shall be drawn into all PVC conduits.

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.

2.03 CONDUIT (FLEXIBLE CONNECTIONS)

A. 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 a corrosion resistant flexible metal tubing with a polyvinyl chloride sheath terminated at each end by a compression gland screwed into the connection boxes. An insulated stranded copper connection of section not less than that quoted in Table 54F of the I.E.E. Regulations shall be provided in each instance to ensure earth continuity.

2.04 CONDUIT (CAPACITY)

A. 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.

2.05 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

3.01 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.

3.02 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.

3.03 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.

3.04 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.

3.05 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.

3.06 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 20mm. 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.

3.07 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.

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

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

3.10 The following general rules shall be adopted**.**

B. Conduit saddles shall be used at every 50 cms where the run is straight.
C. Saddles shall be used on both sides of a bend or coupling.

***** END OF SECTION *****

SECTION 16130
UNDERGROUND ELECTRICAL SERVICE

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Underground Electrical Services including, but not limited to the following:

1. Trenching and backfilling.
2. Manholes, hand holes and earth rod pits.
3. Cable warning signs and tapes.

1.02 RELATED SECTIONS

16000	Electrical Works
16010	General Provisions for Electrical Work
16110	Raceways
16120	Conduits
16200	Cables and Wires
16300	Supporting Devices
16400	Main Distribution Equipment
16500	Lighting
16640	Earthing
16670	Lightning Protection system
16720	Fire Detection and Alarm System
16760	Data System
16771	Public Address /Evacuation System
16772	Audio Visual, Conference, Interpretation System
16960	Building Surveillance System (CCTV)

1.03 REFERENCES

A. The IEE Wiring Regulations, 16th Edition (2001).

B. BS 4568 Rigid Steel Conduits, Zinc Coated.

C. BS 6099-2.2 / IEC 614-2-2 U.P.V.C. Rigid Conduits.

1.04 SUBMITTAL

A. Submit for complete and detailed manufacturer's catalogues and data relating which shall include, but not limited to, the following:

9. Name of the manufacturer.
10. Country of origin.
11. Name and address of agents stating whether any manufacturing or fabrication is carried out locally.
12. Method of obtaining spare parts for maintenance and list of spare parts sufficient for a 2 years period.
13. Technical performance of the equipment selected.
14. Dimensional details needed for installation and maintenance.
15. Delivery time from the date of orders.
16. Copies of test reports or certificates.
17. Control schematics and wiring diagrams.

B. Provide samples of proposed devices together with the above submittal for approval of the Engineer.

1.05 QUALITY ASSURANCE

A. All items for underground electrical services shall be as per manufacturer's standard construction and materials except civil works such as excavation, backfilling and concreting. Where this contradicts any part of the Specifications, the Contractor shall state so at the time of tender.

B. Manufacturers: Firms regularly engaged in the manufacture of such items of the types and sizes required, and whose products have been in satisfactory use in similar service for a period not less than 5 years. Preference shall be given to local manufacturers.

C. All work shall conform to applicable standards of Local Standards Organization and BS.

D. All underground electrical services for power and communications shall comply with the requirements and standards of Electricity Supply Authority and Telecom Supplier respectively.

1.06 DELIVERY, STORAGE AND HANDLING

A. During unloading of PVC pipes and other items for underground electrical services, rough handling shall be avoided. Chains or wire ropes may be used, provided they are suitably covered, to protect the pipes and other items from damage.

B. Unloading by mechanical means such as a crane or fork lift may be used where PVC pipes and other items for underground electrical services are delivered in bundles or in crates. However, consideration shall be given to the total weight and the lifting capacity of the mechanical equipment, and the observance of the statutory safety requirements.

C. PVC pipes and other items for underground electrical services shall not be dropped or thrown to the ground, knocked against other conduits or against sharp objects that any cause permanent damage.

D. In preparing for laying the pipes in trenches, the pipes and fittings may be unloaded along the trench direct from the back of a truck. Ducts and fittings should be unloaded on the side opposite to backfill. Fittings including end bells, couplings and other accessories such as solvent cement and lubricant shall be stored at the trench site under cover to prevent loss or damage.

E. When storing on site, PVC pipes and other similar items shall be placed a level surface and shall be supported to minimize distortion, and protected from direct sunlight. Horizontal supports of adequate width shall be spaced not more than 1.5 m centre to centre beneath pipes to provide continuous and even support.

F. Vertical side supports shall be provided at 3 m spacing on rectangular stacks. The maximum free height of such stacks shall not exceed 1.5 m.

PART 2 - PRODUCTS

2.01 GENERAL

A. Underground Electrical Services for power, lighting, low current systems, control cables and grounding shall comprise manholes and handholes interconnected via concrete encased PVC pipes, direct buried PVC pipes or cable trenching; all as shown on the Drawings and mentioned in the Specifications or required on site for proper installation and maintenance of electrical systems.

B. Any trenching, backfilling, compaction and general grading required for electrical works shall be carried out in accordance with the requirements given in civil works specs.

C. Any metal frames, covers, louvers, etc. related to the works described under this Section shall be carried out in accordance with the requirements given in civil works specs.

D. Any cast in place concrete related to underground electrical services described under this

Section shall be carried out in accordance with Section 03300.

2.02 DUCT BANKS

A. Duct banks shall be either direct buried type or concrete encased type, as applicable and required on site.

B. Heavy duty rigid PVC conduits shall be used for direct buried or concrete encased underground duct systems. PVC conduits and fittings shall comply with the requirements of Section 16130

C. PVC conduit shall be suitable for a temperature range of 4 °C to 90 °C. Conduits within the duct bank shall be supported on plastic interlocking spacers, at intervals of approximately 2.4 m. A 25 mm minimum separation, edge to edge, shall be maintained, both horizontally and vertically, between the ducts.

D. All duct banks shall have a 75 mm concrete cover on the top, sides, and bottom of the PVC ducts. Anchorage shall be used to hold the ducts in place while pouring the concrete encasement.

E. Where the duct bank enters a building below ground level, the conduit shall terminate in an appropriate fitting. An end bell shall be used on conduits entering manholes.

F. After completion of the installation of cables in the duct bank, seal the ends of duct banks using special caulking compound of a putty-like consistency. It shall be workable with the hands at temperatures as low as 1.7 ^{o}C, and shall not slump up to a temperature of 149 ^{o}C. It shall not be harden significantly when exposed to air.

G. A run of conduit shall not contain more than the equivalent of four quarter bends. Bends in conduit shall be made without reducing the internal diameter of the conduit. The inside radius of the conduit bends shall not be less than one metre.

H. Matching end bells and plugs, constructed of high impact plastic, shall be provided through out the duct bank at the ends and in manholes.

I. Each length of conduit shall be provided with one standard coupling. Couplings shall have a center step to ensure proper seating. Joints shall be made with the solvent cement as recommended by the conduit manufacturer.

J. Concrete encasement shall be class C20 concrete with 13 mm maximum size aggregate for all duct banks. For warning purposes, a red dye shall be towelled into the top surface after pouring the concrete.

K. An expansion joint of 55 mm per 100 meters maximum shall be provided in the duct banks. Additionally, a construction joint shall be installed if pouring of concrete is commenced any time after initial set of adjacent concrete. Neither expansion nor construction joints shall be installed under a roadway.

L. For duct banks in stable soils, the soil below the duct bank shall be compacted to 90 % of maximum density to a minimum depth of 300 mm. A dewatering system shall be used to lower the water table below the final excavation depth to eliminate disturbance of in-situ soil densities.

2.03 STUB-UPS

A. Stubs-up for electrical equipment connections and other requirements shall consist of either 100 mm or 150 mm diameter hot double-dipped galvanized rigid steel conduit entirely encased in concrete.

B. Rigid steel conduits and bends for stub-ups shall comply with the requirements of Section 16130.

C. The bends for stub-ups shall be 90 degrees with a minimum radius of 1200 mm.

D. Bends for stub-ups shall serve as transition between PVC conduits embedded below grade and rigid steel conduit installed exposed on surface. Such bends shall be provided with a PVC steel coupling on one end and a threaded male or female adapter on the other end.

2.04 MANHOLES

A. Appropriate type and size of manholes shall be provided as shown on the Drawings or required on site in compliance with the requirements of Local Standards Organization, BS and Electricity supply authority or Telecom supplier regulations.

B. Manholes for communication and low current systems shall be constructed in accordance with the standard practice and requirements of Telecom Supplier. Regulations.

C. A sump pit shall be built into the base slab directly beneath the manhole opening to collect and retain any water present in the manhole. Periodic maintenance may be required since sump pumps will not be permanently installed.

D. The duct bank manhole/interface shall include an expansion joint to take up longitudinal movement due to expansion and construction of the duct bank. This joint shall also act as water stop to prevent water from seeping inside the manhole.

E. The exterior of the manhole shall be waterproofed, with a bituminous coating in accordance with Section 03300.

F. Each manhole shall have two cable pulling irons opposite each duct bank entrance.

G. Access to deep manholes shall be through a chimney. Permanent ladders or rungs shall be installed, if required by the Engineer on site or shown on the Drawings.

H. Manholes shall be provided with earth-rods and cable supports as per the requirements of Local Standards Organization, BS or Electricity supply Authority.

I. The frames and covers of all manholes shall be heavy duty, cast iron, round with solid type gasket lids, and countersunk locking devices. Covers shall seal tightly and not rock, when installed.

2.05 HANDHOLES

A. Handholds' may be formed either monolithically or built up to designed sizes by combining several concrete sections cast in various shapes and sizes.

B. Handholes shall be provided with cast iron covers, sumps, ground-rods, etc. as shown on drawings or required as per the requirements of Local Standards Organization, BS or other applicable standards. Section joints shall be grouted.

C. The frames and covers of all hand holes shall be heavy duty, cast iron, round with solid type gasket lids, and countersunk locking devices. Covers shall seal tightly and not rock, when installed.

2.06 EARTH ROD PITS

A. Earth rods pits shall be provided for all earth rods in accordance with the requirements of Section 16640.

B. Earth rod pits shall be precast of either square or round section with cover.

C. The cover of earth rod pits shall have appropriate marking as approved by the site Engineer.

2.07 CONCRETE PADS

A. Concrete pads shall be provided for all pad mounted equipment.

B. Concrete pads shall be 150 mm high, unless otherwise indicated, complete with steel reinforcement and necessary bolts, anchors, etc. required for the proper installation of pad mounted equipment.

C. Structural calculations for concrete pads supporting heavy equipment shall be submitted for Engineer's approval before commencement of work on site.

2.08 CABLE WARNING SIGNS AND TAPES

A. Where cables are directly buried, cable warning signs shall be installed to minimize the likelihood of damage to the cables by excavation. These signs shall be suitable for mounting on a riser pole, substation fence or separate stakes to suit the installations.

B. Posts for cable warning signs shall be placed as close to the cable as practical, but not closer than 900 mm horizontally from the cable.

C. Cable warning tapes shall be provided in accordance with the requirements given in Section 16120. Tapes shall be placed at least 300 mm above the buried cables, and shall cover full width of the cable trench.

PART 3 - EXECUTION

3.01 INSPECTION

A. Establish and propose exact routes and requirements of underground electrical services for approval of the Engineer, after co-ordination with all other existing or new underground services, before commencement of the work on site.

B. Examine the areas and conditions under which the underground electrical services are to be installed, and correct any unsatisfactory conditions detrimental to the proper and timely completion of the work. The Contractor shall not proceed with the work until all unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

3.02 EXCAVATION AND BACKFILLING

A. Before commencement of the excavation, check the presence of any existing underground service by means of appropriate tools and equipment. The Contractor shall be penalized for damaging of any existing services in accordance with the rules and regulations set forth by the Owner and described in Section 16050.

B. Carry out excavation and backfilling in accordance with the requirements of civil works

3.03 DUCT BANKS INSTALLATION

A. The direct buried PVC ducts shall have a minimum dry sand cushion of 150 mm and a minimum dry sand cover of 300 mm, over which 50 mm thick concrete tiles shall be placed.

B. Depth for direct buried PVC ducts and PVC coated rigid steel conduits shall not be less than 600 mm from finished grade level to the top of conduits.

C. Top of concrete encased duct banks shall be installed 600 mm minimum below finished grade and shall connect manholes and handholes as shown and required on site. Where a duct bank connects to a building, adapt the duct bank, at one meter beyond the building exterior wall, to the building conduit with the required couplings.

D. The concrete encasement surrounding the duct bank shall be rectangular in cross-section, having a minimum concrete thickness of 75 mm beyond any surface of the conduit.

Interlocking spacers shall be used to secure a uniform spacing between conduits of not less than 75 mm.

E. Trenches and duct banks shall be graded so that conduits will have a fall of at least 75 mm per 30 m towards the lower manholes or from the high point of the section towards the manholes or from the building towards a manhole.

F. Changes in direction of duct bank runs shall be accomplished by using special couplings limited to 5 degrees and/or 45 degrees bends having a 1 m radius sweep with straight sections of ducts between changes of direction and `S' sweep sections having a minimum of 500 m offset.

G. Where duct bank enters manholes, conduits shall terminate in end bells. Clean each conduit thoroughly before laying. During construction and after completion of the duct banks, plug the ends of conduits to prevent water washing mud into the conduits. Take particular care to keep the conduits clean of concrete or any other substance during the course of construction.

H. Securely anchor duct and brace with intermediate and base plastic spacers to prevent movement during the placement of concrete.

K. After the completion of portion of duct bank, a mandrel not less than 300 mm long, with a diameter of approximately 6 mm less than the inside nominal diameter of the conduits shall be pulled through each conduit, after which a brush with stiff bristles shall be pulled through to make certain that no particles of earth, sand or gravel have been left in the line. This cleaning shall be done one day after the concrete has been poured.

L. Install a nylon rope in each conduit after cleaning, after which the conduits shall be capped/plugged immediately.

M. All duct banks shall enter manholes through rectangular openings of suitable dimensions provided in walls. Such holes shall be sized to properly receive the duct, but shall not be too large for proper caulking. The space between duct banks and manhole walls shall be caulked tight with lead wool.

3.04 STUB-UPS INSTALLATION

A. Comply with relevant requirement of Section 16130.

B. Exact stub-ups locations and termination requirements for each equipment shall be verified on site, before commencement of laying underground or under floor PVC conduits for required power and control wiring.

C. Where extensions of PVC conduits above grade are required as stub-ups, a transition bend having PVC/Steel coupling on one end and threaded male or female adapter on the other end shall be used.

D. The PVC coated rigid steel transition bend or conduit shall extend minimum 150 mm above grade. A concrete envelope 100 mm high above the finished floor shall be formed around such risers to minimize corrosion at point of emergence. The top of the envelope shall be sloped for drainage.

3.05 CONSTRUCTION OF MANHOLES AND HANDHOLES

A. Manholes and handholes shall be constructed of precast or cast-in situ concrete to sizes shown on the Drawings. Horizontal concrete surfaces of floors shall have a smooth steel trowel finish.

B. Frames and covers shall be watertight and covers shall fit the frames without undue play. These shall be free from warp and blow holes that may impair their strength of appearance.

C. Steel and iron shall be formed to shape and size with sharp lines and angle and shall have a smooth finish.

D. Provide all necessary lugs and brackets.

E. Set pulling-in irons and other built-in items in place before pouring concrete.

F. Provide a 3 m earth rod external to each manhole and handhole. Also provide an earth bar in each manhole and handhole affixed to the wall above the duct bank box-outs. Connect to earth rod using 70 mm^2 bare copper conductor and bond earth conductors associated with each power cable inside the manhole or handhole.

3.06 CABLE WARNING SIGNS AND TAPES INSTALLATION

A. Direct buried cables shall be installed in accordance with the requirements for external cable installation given in Section 16120.

B. Cable warning signs shall mark all direct buried splices and shall be placed at intervals not exceeding 30 m along the cable route.

C. Cable warning tapes shall be installed 300 mm directly above cable throughout the entire cable route and shall cover the full width of cable trench.

***** END OF SECTION *****

SECTION - 16200
CABLES AND WIRES

PART 1 - GENERAL

1.01 All cables shall be designed for operation in systems where continuity of supply is the first consideration. They shall also be satisfactory in operation under the variations of current, voltage and frequency as may be met under fault and surge conditions on the system.

All materials shall be of the best quality and of the class most suitable for working under the particular condition of the systems. They must be capable of withstanding the normal variations of temperature and service conditions without disturbance or deterioration.

In general, cables and wires shall conform to the international standards and to the concerned local authorities Specifications.

1.02 CONDUCTORS

The conductors shall be high conductivity copper, stranded for power cables and solid for control cables' according to the type of insulation, the copper conductors will be plain or tinned.

1.03 Cables shall be installed on cable trays or on building structure as indicated on the Drawings. They shall be neatly fixed in straight lines. On cable trays, cables shall be fixed by cable clips or ties while, on building structure cable cleats shall be used. The spacing of cable supports shall be as indicated in I.E.E. Regulations table B.2M. The minimum radius of bends for cables shall be in accordance with table B.1M of the regulations with bends made neatly and uniformly.

1.04 Where single core cables are used for feeders, care shall be taken to ensure equal division of current among cables which shall be arranged in trefoil formation.

1.05 Proper cable glands of non ferrous material shall be used for cable entries into distribution boards and equipment.

1.06 Each end of each cable shall be provided with identification label lettered with feeder or circuit designation to the Engineer's instructions. The labels shall be permanently fixed in distribution boards, terminal boxes, isolators, etc. and shall be made of durable material ensuring permanent legibility.

1.07 STANDARDS

Unless otherwise specified, cables wires and terminations shall comply with the following standards as appropriate :

Cable and Wires

BS 1442	:	Galvanized Mild Steel wire for armouring cables.
BS 2897	:	Aluminium strip armour for cables.
BS 6234	:	Polyethene insulation and sheath for cables
BS 6360+IEC 228	:	Copper conduct for cables
BS 6746+IEC 540	:	PVC Insulation & Sheath for cables.
BS 6346+IEC 502	:	PVC Insulated Cables
BS 5467+IEC 502	:	Armoured Cables
BS 6004+IEC 227	:	PVC Insulated Cables for Power and Lighting
BS 6500+IEC 227	:	Insulated Flexible Cords
BS 6207+IEC 245	:	Mineral Insulated Cables

Cable Termination

BS 4579	:	Performance of Mechanical and Compression Joints for Cables
BS 6081	:	Termination of MICC Cables
BS 6121	:	Mechanical Cable Glands.

All cable terminations shall comply with the concerned local authorities requirements.

1.08 TESTS

- The cables shall be factory tested in accordance with the applicable standards, codes or recommendations.
- For each cable type, the following test certificates, providing tests have been carried out shall be submitted to the Engineer for approval.

- Mechanical properties of insulation and sheathing components.
- Resistance to cracking.
- Pressure test at high temperature.
- Resistance to flame propagation.

Final tests shall be made at site and the following routine tests will be carried out :

- Conductor resistance test.
- Insulation resistance.

1.09 RELATED SECTIONS

A.	Section 16120	Conduits
B.	Section 16110	Raceways
C.	Section 16300	Supporting Devices

1.10 SUBMITTALS

A. Provide product data for each type of cable.
B. Shop floor drawings showing cable routes and method of laying, spacing and space factor applied.
C. Submit cable assembly from each reel /drum.
D. Provide samples of cable markers, cable ties etc.

PART 2 - PRODUCT

2.01 PVC INSULATED/PVC SHEATHED CABLES

These shall be 600/1000V, single or multi-core conforming to BS 6346 with high conductivity plain annealed stranded copper conductors to BS 6360, PVC insulated with an extruded layer of PVC bedding and a final outer extruded PVC sheath. The insulation and sheath shall be to BS 6746 with insulation coloured to identify phases and neutral in accordance with BS 6746 C. Armoured sheathed cables shall have a single layer of galvanized steel wires for multi-core cables and aluminium wire or tape for single core cables.

2.02 CROSSED LINKED POLYETHYLENE CABLES

These shall be single core or multi-core cables, 600/1000V conforming to BS 5467 with high conductivity plain annealed stranded copper conductors to BS 6360, insulated with cross linked polyethylene (XLPE) to BS 6899 applied by a combined extrusion and vulcanization process to form a compact homogeneous layer, cables bedded and overall sheathed by a black PVC layer to BS 6746. Armoured cables shall have a single layer of galvanized steel wires for multi-core cables and aluminium wire or tape for single core cables.

2.03 WIRES

A. Single core cables shall be plain annealed copper conductor to BS 6360, insulated with PVC to BS 6746, 600/1000 V grade conforming to BS 6004, single core for drawing inside conduits and trunking.

B. Single core cables shall be continuous from outlet to outlet and no splice shall be made except within outlet and junction boxes. A separate neutral wire shall be provided for each circuit. Wires shall be left sufficiently long to permit making final connections. The colour of insulation shall be as specified in IEE regulations for different phases, neutral and earth wires.

2.04 FLEXIBLE CORDS

Flexible cords shall be circular silicon rubber insulated glass fiber braided, three core 300/500 volts and shall comply with BS 6500. The conductors shall be tinned, annealed copper and the core shall be coloured Brown, Blue, Green/Yellow for identification.

2.05 MICC CABLING/WIRING

In all hazardous areas the cabling/wiring shall be done with MICC cables/wires. The decision of the engineer in respect of choosing such areas will be final and binding. Generally such areas are gas stores, areas handling medical gases, cold stores etc. MICC cables shall be to the following standards:

Flame Proof Barrier	BS 5345 Part 1
Manufactured & Tested to	BS 6207
Quality Assurance	BS 5750
Cable Terminations	BS 6081
IEC Standards	IEC 702.1/IEC 702.2

PART 3 - EXECUTION

3.1 GENERAL

Cables/wires shall be installed as per the concerned local authorities regulations. Where no concerned local authorities regulations exist IEE regulations shall be followed.

3.2 EXAMINATION

A. Verify that interior of the building has been protected from weather

B. Ensure that all raceways are thoroughly cleaned.

C. Verify that all construction works likely to damage wires /cables have been completed.

3.3 INSTALLATION

A. Use suitable wire /cable pulling lubricants.

B. Support cables above accessible ceiling. Do not rest cables on ceiling panels.

C. Use suitable rollers and pulling devices.

D. Perform field inspection and testing in the presence of the Engineer.

E. Verify all earth continuities.

F. Identify all circuits (Cables) with appropriate marking devices.

***** END OF SECTION *****

SECTION 16300
SUPPORTING DEVICES

PART 1 - GENERAL

1.01 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.

1.02 DESCRIPTION

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

1.03 RELATED WORKS SPECIFIED ELSEWHERE

A.	Section 16120	Conduits
B.	Section 16110	Raceways
C.	Section 16200	Cables & Wire

1.04 REFERENCE STANDARDS

Lighting Switches	BS 3676 part 1/1989 & CENELECPREN60669-1
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

2.01 SOCKETS

A. Sockets shall be 250V, three pin, 16A 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.

B. UPS Socket outlets should be differentiated from the normal supply socket outlets by color (Blue).

C. Sockets shall be fixed inside galvanized stamped steel boxes which shall be flush mounted in walls.

D. Pedestal mounted floor outlets shall be provided in locations where no wall or column is available

E. Sockets shall have White moulded cover plates as approved by the engineer The mounting heights for wall sockets shall be 300mm above finished floor level unless otherwise indicated on the Drawings.

F. 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.

G. Sockets working on normal plus emergency supply shall be provided with neon indicator which will remain illuminated even in off position.

I. Weatherproof sockets outlets shall have the weather tightness as mentioned in paragraph `E' above and shall comply with the concerned local authorities Specifications.

J. Terminal shall be grouped in-line with terminal screws backed out and terminals shall be marked.

2.02 JUNCTION BOXES

The junction boxes shall be DP 250V 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 moulded & provided with flex outlet.

2.03 SWITCHES

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

B. Switches shall generally be flush mounted and of grid type at a height of 1200mm 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.

C. Weatherproof switches shall have weather tightness as per Clause 2.01 (F) above.

D. 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.

2.04 DIMMER SWITCH FOR FLUORESCENT TUBULAR LAMP

Remote control potentiometer unit shall be used for electronic dimmable ballast shall be used. It shall have a rotary switch for ‘ON\OFF’ function and a control voltage range with “MAX” and “MIN” trimmings.

2.05 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.

2.06 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.

2.07 DOUBLE POLE SWITCHES

The double pole switches shall be with indication neon lamps and shall be rated 20 amps unless otherwise mentioned. The face plate shall as per the concerned local authorities Specification G.3.2 and G.3.3.

2.08 SPARKLESS SOCKET OUTLETS

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

2.09 SPARKLESS SWITCHES

All such switches shall conform to degree of protection as applicable to non sparking equipment.

2.10 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.

2.11 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.

2.12 ISOLATORS AND SWITCH FUSES

A. 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.

B. 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.

C. All outdoor isolators and switch fuses shall be in weather proof enclosures.

PART 3 - EXECUTION

3.1 MOUNTING HEIGHT

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

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

C. 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 1350mm above finished floor level and sockets shall be fixed at 300mm above finished floor level unless otherwise required for specified uses e.g. Above bench or near the equipment etc.

3.2 FIXING

A. Fix outlet boxes securely

B. 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

A. 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

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

3.5 SPARES

Contractor / supplier shall provide 2 % of all supporting devices to the client for future use before certificate of completion of the project.

***** END OF SECTION *****

SECTION 16400
MAIN DISTRIBUTION EQUIPMENT

PART 1 – GENERAL

All Electrical Distribution equipment should be type tested assembled by approved factory.

1.01 DESCRIPTION

A. The main distribution equipment shall comprise main low tension switch boards, switching metering panels, main and sub-main switch boards, distribution boards, isolators, switch fuses ...etc.

B. The supply and distribution arrangement shall be as indicated on schematic diagrams in the Drawings.

C. The equipment shall be assembled and tested in the factory of the approved local panel builder/manufacturer. Where any equipment need to be assembled at site, a prior approval of the engineer would be necessary.

D. 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.

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

1.02 REFERENCE STANDARDS

Switchboards 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	Bus bar & 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	Direct Acting Indicating Electrical Measuring Inst.
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)	Low voltage Switchgear & control gear assemblies

1.03 RELATED WORKS

Section 16110	Raceways
Section 16120	Conduits
Section 16200	Cables and Wires
Section 16300	Supporting devices
Section 16620	Diesel Generator
Section 16635	Earthing

1.04 SUBMISSION

A. Shop Drawings

Submit dimensional shop drawings including sections and elevations and showing positions of major components position and method of fixing and terminating cables.

B. Project Data

Submit full specifications of the enclosure and the components of the switchgear and switchboards and panels.

PART 2 - PRODUCT

2.01 MAIN LOW TENSION PANEL BOARDS

A. The main low tension switch boards shall be of indoor construction, dead front, metal enclosed free standing, dust and vermin protected, front operated and of clean and modern appearance.

B. The switchboards shall be assembled and coordinated by one manufacturer and shall be constructed in accordance with B.S. 5486 : part 1.1977/IEC 439.

C. The panel shall be of the cellular cubical type class 2CC FBA and shall be of the folded sheet steel construction fabricated out of electro galvanized cold rolled sheets of minimum 2mm thickness for body and frame work and not less than 1.5mm for doors and cover plates.

D. The panels, after fabrication, shall be thoroughly cleaned in a vapor degreasing tank to remove all traces of oil and wax and provided with a coat of electrostatic, polyester powder coating, light grey colour, shade No. 10A03 to BS 4800.

E. All doors and removable cover plates shall be provided with neoprene gasket so as to obtain degree of protection IP53 to IEC 144.

F. Each outgoing breaker shall be enclosed in its own compartment (cell) fitted with a hinged door interlocked with the operating handle in such a way that:

1. It shall be possible to open the door only when the handle is in 'OFF' position.
2. It shall not be possible to switch the unit 'ON' when the door is open.

Moreover, no live parts shall be exposed when the compartment door is open.

G. Protection against shock shall be provided in accordance with the requirement of BS 5486 Part 1.

H. The switchboard shall be of the rear access pattern and vertical cable way shall be provided in each section of the switchboard. The cable way shall be provided with bolt-on covers. All terminals in the cable way shall be fully shrouded to prevent accidental contact when the covers are removed.

J. All external bolts or screw heads shall be chrome or cadmium plated.

K. The equipment in the switchboard shall be accessible with indicating instruments mounted not higher than 1.8m. And the centerlines of operating devices not higher than 1.8m. Above switchboard base. The switchboard shall be properly fixed to the floor with foundation bolts grouted in the floor or bolted to channels laid across the cable trench.

L. The switchboards shall have top or bottom cable entry as required. Basically, main incoming cables shall be bottom entry and outgoing cables top entry.

M. The switch boards shall contain the air circuit breakers, bus bars, bus couplers, MCCBs, instruments, earth bus, ...etc. as specified here under and as per drawings with ratings and arrangement as shown on the Drawings and shall be complete with all internal wiring and connections.

N. The switch boards shall be tested at the manufacturer's premises as well as commissioned after installation in accordance with tests stipulated in IEC 439.

O. Additionally, Main Low Tension Switch Board shall comply with the concerned local authority's requirements.

2.02 BUSBARS

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

B. The horizontal and vertical bus bars 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 are removable by tool or special key.

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

D. The bus bars 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.

E. The Main Low Tension Panels (MLTPs) busbar 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 bus bars shall be provided with colored PVC sleevings at regular intervals for phase identification. Painted bus bars may be acceptable in special cases when panels are manufactured/assembled in Jordan.

2.03 AIR CIRCUIT BREAKERS

A. The air circuit breakers shall be of the air break trip free draw out type with the main contacts encased in a reinforced polyester casing and offer double insulation from the operators on the breaker front face. The air circuit breaker shall be fully tropicalized (T2) as defined in IEC 68.2.30 and shall have salt spray resistance as per IEC 68.2.11. The ACB shall comply with IEC 947.2 utilization category B with Ics=Icu=Icw and shall accept reverse feeding without reduction of performance. The ACB shall comply with the isolating function requirements of IEC 947.2 section 7.1.2 and shall have minimum 500 V 50Hz operational voltage, 1000 V 50 Hz rated insulation voltage and 8kV withstand surge voltage (Vimp). The 3-pole and 4-pole versions shall have ratings as shown in the drawings. In the 4 pole version the neutral pole shall have the same current rating as the other poles from 800 to 4000A . The breaking capacities shall not be less than 50 kA symmetrical for 1 sec. at 415 volt. Evidence of the service breaking capacity (Ics) shall be produced by test certificates from one of the internationally recognized testing Laboratories. (ASTA, CESI, ESEF/ASEFA, KEMA, PEHLA or SATS).

B**.** Unless otherwise mentioned the ACB shall be of the O-C-O stored energy spring type with a closing time less than or equal to 80 millisecond. Electrically operated circuit breakers shall have the spring charging motor connected so that the springs remain charged always with the motor disconnected after charging. The spring charging time shall not exceed 4 seconds. A standby manual operating handle for spring charging shall be provided for operating the circuit breaker in case of power or motor failure. Antipumping shall be provided by integral devices to prevent reclosing after a close-open operation if the closing impulse is maintained after the breaker has opened. External relays are not acceptable

C. The circuit breaker shall have three positions of the drawout mechanism, namely service position where all main and auxiliary contacts are made, test position where main contacts are open but auxiliary contacts are closed and isolated position where all contacts are open. Mechanical indication on the front of the ACB shall be provided to indicate

A) Main Contacts Closed 'On',
B) Main Contacts Open 'Off',
C) Springs Charged,
D) Springs Discharged
E) Service Position,
F) Test Position, And
G) Isolated Position For Drawout Mechanism.

D. Any attempt to withdraw or insert the breaker when it is 'ON' shall trip the breaker automatically. An interlocking shall be provided to prevent insertion of a circuit breaker having a rating higher than the current rating of the ACB cradle.

E. Insulated safety shutters shall screen all live parts in the ACB cradle when the breaker is in the isolated or racked out position.

F. The moving contacts comprising the main and arcing contacts shall have visual wear indicator and be of the spring loaded type. The main contacts and clusters shall be site replaceable. The electrical endurance shall not be less than 4000 operations for rating up to 3200A and not less than 2000 operations for ratings above.

G. The circuit breakers shall have sufficient number of auxiliary contacts for interlocking system as indicated and described on the drawings and for interfacing with building automation system (BAS), with two spare sets of normally open and normally closed contacts. It shall be possible to connect all auxiliary wiring from the front face of the air circuit breakers and this wiring shall be taken through a set of disconnecting contacts, so that all auxiliary wirings are automatically disconnected in the isolated and drawout positions.

H. The circuit breakers shall be equipped with MCR, overcurrent and earth leakage protections by means of integral self-powered microprocessor based solid state RMS sensing current relays. The long time overcurrent protection shall have a setting range between 40 and 100 per cent of sensor rating in steps of 2 per cent. The corresponding time delay shall be adjustable from 15 to 480 seconds The short time overcurrent protection shall have a setting range from 40 per cent to 15 times the sensor rating. The corresponding time delay shall be adjustable from 15 seconds. The sort times the sensor rating. The corresponding time delay be adjustable from instantaneous to 400 milliseconds with the possibility select time inverse characteristic for improved discrimination. Instantaneous overcurrent protection shall be adjustable from 2 times the current up to the circuit breaker electrodynamical withstand. The earth protection shall have current settings from 10 per cent of the rated current 1200 A in steps of 10 per cent. The time delay setting shall be variable 100 millisecond to 400 millisec in steps of 100 millisec.

J. The RMS value of the phase currents and interrupted current values shall be displayed on the built-in digital ammeter and the LED's shall indicate the type of fault on the front face of the trip unit. An indicator shall give indication of the main contact wear according to the number of operations and the values of the switched currents. A bar graph shall display the load indication of each phase and the highest value of phase currents shall be stored and displayed on demand. Trip unit malfunction or internal overheating shall be indicated by a self monitoring alarm.(Some features may differ from one manufacturer to another)

K. The air circuit breaker used on bus-section shall be identical to Air Circuit Breaker specified but with only the Making Current Release (MCR) protections and instruments specified but with the following indications :

1. Circuit breaker closed.
2. Circuit breaker open.
3. Circuit breaker tripped.

L. The main low tension panels shall be provided with cable boxes to suit the incoming cables from the transformer which are supplied and installed by the concerned local authorities.

2.04 CURRENT TRANSFORMERS

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.

2.05 INSTRUMENTS

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

B. 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.

C. Ammeters shall be moving iron type, to B.S. 89 scaled 0-2000 A for main incoming supply.

D. 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.

E. Maximum demand indicators shall be of the thermal type with a 15-minute time delay.

2.06 kWh METERS

A. The kWh Meters for the concerned local authorities shall be suitable for operation on 415/240 volts, 3 phase, 4 wire, 50 Hz supply.

B. The meter shall be absolutely dust and vermin proof, protected from corrosion due to high humidity and compensated against the effect of temperature upto 55 Deg.·C.

C. The Meters shall maintain their accuracy over many years service under Jordan climatic conditions. The counters shall be of the cycle-meter type with six digits and shall give a direct reading of power consumption to six figures, the lowest figure being units and not tenth of units. Pointer type counters are not acceptable.

D. Multiplying factors shall not be used except for the larger size of current-transformer operated meter, where 10 and 100 may be used. The calibrating adjustments shall be operated by screw-driver only.

E. The Meter cover and cases shall be of metal and not plastic.

F. The ratings for direct connected whole current meters shall be 50, 75 and 125 amperes maximum per phase and the terminal holes shall not be less than 6,9 or 12mm. diameter respectively.

K. Higher ratings meters shall have not less than 5mm. diameter terminal holes and shall be operate through current transformers with 5 amperes rating to the secondary side and the counter or the meter shall be calibrated to read the primary Kwh passing through the current transformers.

L. The current transformers shall be of the ring or slide on busbar type.

M. Three current transformers of 2000/5A shall be provided for each meter.

N. All meters shall be handed over to the concerned local authorities for Calibration before final erection and connection.

2.07 FUSE SWITCHES

A. Fuse switches shall fully comply with BS 5419 : 1977, IEC 408 : 1972 meeting all of the concerned local authorities requirements.

2.08 MOULDED CASE CIRCUIT BREAKERS

A. The moulded case circuit breakers shall comply with IEC 947-1 and IEC 947-2 standards and shall be of the quick make and quick break type having free toggle mechanism ensuring full contact pressure until time of opening, whether actuated automatically or manually. They shall be of utilization category 'A' having rated service breaking capacity (Ics) as indicated in the drawings. The circuit breakers shall be suitable for isolation as per IEC 947-2 and shall have rated operation voltage of 500V 50 Hz, insulation voltage of 750 V, 50 Hz. The breaker shall be available in 3 or 4 pole version as per the drawing. All poles shall operate simultaneously for circuit breaker opening, closing and tripping. The mechanism shall be completely enclosed in the compact moulded bakelite case. The moulded case circuit breaker shall provide class II insulation (according to IEC 664) between the front and internal power circuits. The breaker shall be designed for both vertical and horizontal mounting and it shall be possible to supply power either from the upstream or downstream side without any adverse effects on the electrical performance. Evidence of the service breaking capacity (Ics) shall be produced by test certificates from one of the internationally recognized High Voltage Laboratories (ASTA, CESI, ESEF/ASEFA, KEMA, PEHLA or SATS).

B. Breakers contacts shall be made of non-welding and non-corrodible composition. Circuit breakers shall be actuated by a toggle or handle that clearly indicates the three positions 'ON', 'OFF' and 'TRIP' thus indicating clearly abnormal conditions of the circuit. In order to ensure suitability for isolation complying with IEC-947-2, the operating mechanism shall be designed such that the toggle or handle can only be in OFF position if the power contacts are all actually separated. The molded case circuit breakers shall be able to receive a locking device in the "isolated" position and there shall be a "push to trip" button in front to test operation and the opening of the poles. The circuit breaker rating, the 'push to trip' button, outgoing circuit identification and the contact position indication must be clearly visible and accessible from the front, through the front panel or the door of the switchboard. Single pole breaker with handle tie or bar equivalent construction are not acceptable for a multi-pole breaker. Molded case circuit breakers shall be the fixed type. Plug in type breaker connections are not acceptable.

C. Breakers shall have the rating and rated service breaking capacity (Ics) as per IEC 947-2 as indicated in the drawings. The breakers shall be of current limiting type. For short circuits, the maximum thermal stress I^2t shall be limited to 10^6 A^2s for ratings up to 250A and 5 x 10^6 A^2 s for ratings above up to 630A.

D. Circuit breakers shall have inverse time tripping characteristic with automatic release secured through action of a combination of thermal-magnetic or electronic trip units which shall trip free of the handle and operate in response to an overload or a short circuit.

D. It shall be possible to equip the moulded case circuit breaker with a motor mechanism if needed and closing of mechanism shall take place in less than 80 ms. The operating mechanism shall be of the stored energy type only. The addition of motor mechanism or a rotary handle shall in no way affect circuit breaker characteristics and shall not block device settings.

E. The MCCB’s shall be designed for adding auxiliary contacts such as shunt or undervoltage releases after installation at site. The auxiliaries shall be separated from power circuits. It shall be possible to install auxiliary switches for fault/status indication in already energized MCCB without the need to trip the MCCB.

G. It shall be possible to assemble earth fault protection of MCCB’s by adding a residual current device directly to the circuit breaker case and it shall operate without an auxiliary power supply. The add on RCD’s shall comply with appendix B of IEC 947-2 standard. They shall be immunised against nuisance tripping as per IEC 255 and IEC 801-2 to 801-5 standards

H. MCCB with ratings upto 250A shall be equipped with thermal magnetic or electronic trip units which are fully interchangeable types. The breakers with ratings over 250A shall be equipped with electronic trip units which shall remain operational for ambient temperatures upto 60°C. Electronic trip units shall comply with appendix F of IEC 947-2 standard. It shall be possible to fit lead seals to prevent unauthorized access to the settings of the electronic and thermal magnetic trip units.
MCCB’s equipped with thermal magnetic trip units shall have adjustable thermal protection and fixed magnetic protection for current ratings upto 160A. For current ratings greater than 160A the thermal magnetic trip units shall be adjustable from 5 to 10 times the current rating. In four pole breakers the neutral pole shall have the tripping threshold equal to that of the phases unless otherwise stated in the drawings.

K. MCCB’s upto 250A frame size equipped with electronic trip units shall sense the actual RMS values for:
a) long time protection from 40% to 100% of the trip unit rating,
b) the short time protection shall be adjustable from 2 to 10 times the thermal setting,
c) the instantaneous protection shall have the threshold fixed between 12 and 19 times nominal current, depending on the rating.

L. MCCB’s over 250A up to 630A frame size shall be equipped with electronic trip units shall sense the actual RMS values for: : a) long time protection from 40%

to 100% of the trip unit rating, b) the short time protection shall be adjustable from 2 to 10 times the thermal setting, c) the instantaneous protection threshold shall be adjustable from 1.5 to 11 times nominal current and d) a thermal memory (in the event of repeated overloads, the electronic trip units shall optimize protection of cables and downstream devices by memorizing temperature variations). A load monitoring function shall be an integral part of the electronic trip units indicating four load levels (60%, 75%, 90% and 105%) by LED's (with flashing LED for 105%). It shall be possible to install with the electronic trip unit a high threshold earth fault protection, load monitoring and LED's in front to indicate the cause of tripping. It shall be possible for the MCCB to communicate with Building Management System (BMS).

M. The following frame sizes shall be adopted for different breakers:

upto 80A	100/125A frame size
100A to 160A	250A frame size.
250A to 350A	400A frame size.
350A and above	630A frame size

N. Each MCCB's shall have minimum 2 pairs of NO /NC auxiliary contacts

2.09 EARTH LEAKAGE RELAYS

A. Earth Fault Relay

a. The relays shall comply with IEC 755
b. The relays shall be protected against nuisance tripping caused by switching surges or by lighting surges.
c. The relays shall be of solid state type (mechanical type shall not be accepted),self protected from high magnitude earthfaults and protected against dirt, vibration and moisture.
d. The relays shall be able to operate in the presence of fault currents with DC components.
e. Each relay shall accept a wide range of auxiliary supply voltages from 48V to 240V AC and 48V to 300V DC as per the requirement in the drawings.
f. The sensitivity of relays shall be adjustable as per the requirement in the drawings from 0.03A to onward. The relays shall have time delay option if required from instantaneous to 1 sec. using an 8 position switch.
g. The size of the relays shall be compact. They shall be suitable for mounting on symmetrical rail horizontally or vertically.
h. The relays shall be equipped with one changeover output contact. The continuity of the measurement circuit shall be monitored to ensure that the toroid circuit is not open.

B. Current Sensors (Toroids)

a. Rectangular type for busduct feeders
b. Circular type for cable feeders

c. The range of associated toroidal transformer shall be of the closed type with an inside diameter of 30 to 200 mm.

d. To have cable guides to ensure that feeder cable is centered within the sensor.

e. The maximum link resistance from toroid to relay link must not exceed 3 ohms.

Current operated earth leakage relays shall be used either in conjunction with circuit breakers for tripping the breakers or for giving alarm signal only by an indicator lamp and alarm bell in cases of earth leakage.

2.10 EARTH BUS

The copper earth bus shall be minimum 50% of the phase conductor size extending throughout the length of the switch board and fixed to the steel members of the switch board. The earth bus shall be extended at the ends for connection to the earth electrodes and shall have provision for terminating earth continuity conductors.

2.11 MAIN AND SUB-MAIN DISTRIBUTION BOARDS

A. 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.

B. Main and sub-main distribution boards shall comprise main incoming isolator, busbars, moulded 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.

C. The main isolator shall be a triple pole and neutral moulded case circuit breaker without tripping element.

D. The busbars shall be high conductivity copper bars to B.S. 159 with ratings as indicated on the Drawings for the three phases and neutral. The busbars shall be arranged and marked to the approval of the Engineer.

E. The moulded case circuit breakers and earth leakage relays shall be as specified in paragraph 2.08 and 2.09 above.

F. The rated service breaking capacity (ICS) of MCCBs shall be 50 KA for MLTP, 28KA for MDBE, 22 KA for MSBs and MCCs, 14 KA for SMSB and MCC fed from MSB unless indicated otherwise on the Drawings.

G. The earth bus shall have adequate rating and length for connecting the incoming and outgoing earth wires or tapes.

H. The distribution boards shall be complete with all necessary internal wiring and connections

J. High conductivity copper bars or rods covered by coloured PVC sleeving for phase identification shall be employed for connections of 200A and higher. For smaller connections PVC insulated cables to B.S. 6231 shall be used with coloured insulation for phase identification.

K. The arrangement of the boards shall be such that the main isolator and MCCBs can be operated when opening the door but to gain access to the MCCBs, cabling and terminations a second cover should be removed. There shall be ample clearance and ample space available inside the boards for cabling and terminations. Adequate clearance shall be maintained between phases and non-current carrying metal and terminals shall be so located that in the final connected positions there shall be no crowding of wires in close proximity of metal.

L. The boards shall be complete with cable glands for convenient terminations of incoming and outgoing cables. The cable glands shall be so fixed inside the board that ample clearance exists between various feeders.

2.12 M.C.B. DISTRIBUTION BOARDS

A. MCB distribution boards shall comprise of a totally enclosed dust and vermin protected, factory fabricated heavy gauge sheet steel enclosure of 2mm thickness and door of 1.5mm thickness and of ample size with a hinged door and approved fastening device. The enclosure shall contain an isolating switch, adequately rated busbars for phases, neutral connector blocks, earth terminal block and single or triple pole miniature circuit breakers with ratings and arrangement as shown on schedules. DB enclosures shall be suitable for 18 or 24 or 36 SPN ways, has the case may be. HRC fuses shall be provided in MCB Distribution Boards where fault level exceeds 6KA.

B. In corridors DBs enclosure shall be housed in electrical closets. All electrical closets shall be of the same size with architectural finishes as required.

C. All risers falling in areas like corridors or important rooms shall be provided with an hinged access door with finishes as required by architect.

D. The main isolating switch shall be of SPN or TPN air break design. Where indicated on the Drawings, the MCBs for the lighting circuits and socket outlet circuits shall be electrically separated by the provision of separate busbars and each section shall be protected by a separate current operated earth leakage circuit breaker. The RCCB shall afford earth leakage protection for the lighting and power sections. Fuses shall be provided for DBs wherever necessary and/or shown on drawings.

E. The neutral and earth terminal blocks should be provided with arrangement for connecting on each block one cable for each outgoing circuit and one incoming cable of size indicated on the Drawings. The wiring between the RCCB and busbars shall be carried out with coloured PVC insulated cables with copper conductors for phase identification. The arrangement of the enclosure shall be such that the MCBs and COELCB cannot be operated without opening the hinged door but to obtain access to MCBs and COELCB, it should be necessary to remove a second cover. Adequate clearance shall be maintained between phase and non-current carrying metals. Terminals shall be so located that in the final connected positions, there shall be no crowding of wires in close proximity of live metals.

F. MCBs shall be so arranged in the board that it shall be possible to replace a triple pole MCB with three adjacent single pole MCBs or vice versa. The board shall be flush mounted type unless indicated otherwise on the Drawings. Cable glands shall be provided where required.

G. MCB

MCB shall comply with EN60439-3 and shall be symmetrical rail mounted type available in one, two, three or four poles version. They shall be trip free type with quick make, quick break mechanism. The rated ultimate breaking capacity (Icu) of the MCB's shall be at least equal to the prospective fault level at the point of the distribution system where they are installed, unless cascaded with an upstream breaker. The minimum rated ultimate breaking capacity (Icu) of the MCB shall be 10 kA if not mentioned on the drawings. MCB can be reverse fed without reduction in performance. Trip setting as indicated on the schedules of points. The MCB shall have thermal overload trip to accept 5% overload and to trip at 30% of rated current as per IEC 947-2. The instantaneous magnetic trip shall operate at 5 to 10 times the rated current for 1P, 2P, 3P or 4P breakers. It shall be possible to replace 3 single phase units with one 3 phase unit. The breakers shall be of current limiting type (DIN type**)**. The quick lag type breakers (QL/plug in type) are not acceptable. Evidence of the ultimate breaking capacity (Icu) shall be produced by test certificates from one of the internationally recognized High Voltage Laboratories (ASTA, CESI, ESEF/ASEFA, KEMA, PEHLA or SATS).

The operating mechanism shall be mechanically trip free from the operating handle so as to prevent the contacts from being held closed against short circuit and overload conditions. It shall be "automatic resetting type". The individual operating mechanism of each pole of a multi pole MCB shall be directly linked within the MCB casing and not by operating handles. The operating handle shall be of the toggle type with possibility of padlocking facility and rotary handle. Each pole shall be provided with bi-metallic thermal element for overload protection and magnetic element for short circuit protection. Current discriminations tables shall be provided for each rating of the breaker. The terminals shall be of the tunnel type (IP 20) in order to minimize the risk of direct contact. It shall be possible to fit on site auxiliaries like shunt trip coil, undervoltage release, ON-OFF switch, alarm switch or residual current device 30 or 300 mA with remote tripping possibility.

The term ‘rcb’ /’rcbo’ shall denote an mcb with built-in earth leakage protection.

H. RESIDUAL CURRENT CIRCUIT BREAKER (RCCB)

RCCB shall comply with CEE 227 or IEC 1008 standards. The RCCB shall provide the functions of isolation, switching and earth leakage protection of electrical circuits. They shall have a residual current operated electromechanical release which operates without auxiliary source of supply to an earth leakage fault between active conductors and earth. RCCBs shall incorporate a filtering device preventing the risk of unwanted tripping due transient voltage. They shall provide a high degree of protection against earth faults, fire hazards and electric shock.

RCCBs shall be available in 2 and 4 pole versions with current ratings from 16A to 100A and an earth leakage trip rating as specified in the schedule of points. They shall be suitable for operation on 415V, 3 phase, 4 wire, 50 Hz supply. They shall have an operating temperature from -5 to + 60° C. RCCB shall have a trip indication on the front face by a red mark. It shall be possible to achieve vertical discriminations with RCCBs.

RCCB alone shall have a short circuit withstand capacity of 3 KA. RCCB must be protected with short circuit protective devices installed upstream inside the DB enclosure having appropriate fault level protection.

RCCB shall consist of the following mounted in a robust body of all insulated material:

- A current transformer
- A tripping coil with contact assembly
- Main supply contact
- On/Off switch
- A test button
- A trip free mechanism

Where a RCCB is used a s a separate item and not housed within a distribution or switchboard, it shall be housed in a dust protected enclosure to prevent accidental contact with live terminals.

I. Where contactors are shown in DBs, the distribution board shall deemed to be understood as a multiple section board.

J. All outdoor MCB distribution boards shall be in weatherproof enclosures.

K. The term RCB shall mean an MCB with built-in earth leakage protection similar to‘Quickguard’ of Square-D

L CONTACORS

The contactors shall conform to BS 775, IEC 947-4 suitable for Class II duty and having a making and breaking capacity in accordance with utilization category AC3.
Unless specially required otherwise the operating coil shall be rated for 240V 50Hz.
Contactors shall be rated for continuous duty.
Contactors not forming a part of Distribution Board shall be housed in a purpose made enclosure having appropriate IP rating suitable to the mounting location

M PULSE RELAYS

Pulse relays shall be suitable AC or DC operation as per system manufacturer Normal practice. The operation voltage may be 240V 50Hz or 24V DC
The pulse relay shall be suitable for actuation manual through built-in Push button.

2.13 MOTOR PROTECTION

Motor Protection against the short-circuit shall be achieved by motor circuit breakers of moulded case type and the combination with control-command devices (Breaker + Contactor + Overload relay) shall be of type 2 co-ordination as defined by the IEC standards 947-4.1. The type 2 co-ordination should be tested in laboratory and the manufacturer should guarantee the same by submitting the type-2

Co-ordination tables. The co-ordination table shall indicate for each motor rating, the circuit breaker type and set up characteristics, the contactor type and the thermal relay type with its setting range.

The specifications mentioned in the MCCB's section is applicable for the breakers used in the motor protection. The moulded case circuit breakers used for motor protection shall be equipped with adjustable magnetic trip unit for short-circuit protection with settings from 6 to 14 times the nominal rating of the device.

The contactors used for Motor protection shall have contactor utilization category AC3 at 415V 50Hz as per IEC 947-4. Tripping class for overload relays used for motor protection shall be of one of the tripping class (class 10A, 10, 20, 30) as per IEC 947-4 depending on the motor starting characteristics.

2.14 ELECTRONIC SOFT STARTERS

Where these starters do not fall under the electrical sub-contractor's scope of work, the specifications may be used for all co-ordination works.

The concerned factory manufacturing the equipment must be ISO 9001 certified for quality assurance and the product supplied shall bear the CE mark.

Contractor to provide complete coordination / selection table prepared by the soft starter manufacturer and indicating clearly the recommendation components such as fuses, breakers, contractors and overload relays so as to achieve Type – 2 coordination as per IEC guidelines. These components shall be from the same manufacturer for easy substitution and consistent operational reliability of the equipment. Mixing of brands is wholly unacceptable. The soft starters in general shall comply with the following.

Enclosure

- Equipment shall be manufactured in accordance with IEC regulations.
- The enclosure used shall be adequate per EMC and Low Voltage directives. The equipment shall be CE marked.
- Units above 20A shall be fitted with adequate forced air-cooling (fan-type).

Control Circuit

The soft starter shall comprise a uP – type control arrangement (PCB based) for triggering control and offer as a minimum, the following functions, selectable using DIP-switch or settable using potentiometers:

- Start Ramp (settable) for upto 60 sec.
- Stop Ramp (settable) for upto 240 sec.
- Startup Voltage (settable) 10 to 60%
- Stop Voltage (settable) 10 to 60% (for Pump Stops)
- Current limit during start (settable)
- Energy saving feature (selectable) for optimal power factor, current and efficiency levels on a real time basis, provided with activation delay (selectable).
- Kick start function for transient high-torque condition to overcome high initial inertia/friction loads (selectable)
- High Current Trip (selectable)

Status indications shall comprise as a minimum, LED display of the following:

- Fault (internal)
- Phase Loss
- Overload
- Ready
- Running
- Ramp-up complete
- Energy Saving function active (if selected)

Further as a minimum, the following volts-free signals shall be made available:

- Fault
- Overload
- Ramp-up complete

Power circuit

The following features shall be provided as standard:

- Start and stop ramp to be achieved using reduced voltage triggering of thyristors connected in antiparallel, with each phase individually double-protected by adequate snubber circuits and varistors to withstand 4kV at 2.5Hz for 60 seconds or more.
- Diode-thyristor paralleling in unacceptable.
- Starter shall be suitable for continuous duty. Further, the circuit must be suitable for constant mains voltage, even when starter is not in use.
- Electronic overload relay to be provided as option in all ratings above 30A and as standard feature for heavy-duty applications to protect the unit from thermal overloads, phase-loss and locked rotor conditions. In addition, an option of over-current trip (selectable) shall be provided to prevent damage due to short-circuits.

External electronic or thermal overload relays may be proposed as an option.

- Adequate heat sinking shall be provided. Further, a thyristor overheat trip shall be provided for added protection.
- Adequately sized terminals shall be provided for linking to cables. Where busbars are used, terminal expansion attachments shall be provided accordingly.

Technical Support

The equipment shall be supplied complete with comprehensive documentation comprising the installation and operation instructions. In addition, the following documentation shall be provided on request and where applicable:

- Selection details including starting curves based on manufacturer’s recommendations.
- Coordination tables (where used) for Type-2 coordination as per IEC.
- Connection drawings for the scheme used.
- Basic trouble-shooting guide (if not already included in the ops manual)

General

The equipment shall be compliant with the following wrt operation:

- Rated installation voltage of 690Vac.
- Starter shall be typically for minimum 6 starts per hour (subject to application type and kW rating)
- For units used in continuous running with fewer starts, a bypass contactor recommended by the soft starter manufacturer shall be used to minimize heat loss.
- Actuation of bypass contractor shall be achieved by using relay output on completion of ramp up.
- Operating temperature shall be 0oC to 50oC with adequate derating where required (application dependent). Also, the equipment shall be suitable for normal operation without derating, within an altitude range of 0-1000 meters.

2.15 ELECTROMECHANIC MOTOR STARTERS

Where these starters do not fall under the electrical sub-contractor's scope of work, the specifications may be used for all co-ordination works.

A. Provide motor starters of electromagnetic, air break type suitable for 3 phase, 50 Hz., 415V, AC System and in accordance with IEC 947-4

B. Starters shall be of the plug-in type mounted on withdrawable trays including power and control plug pins and earthing contact with facilities for padlocking.

C. Starters controlling motor less than 11 KW may be of the direct on line type. For motors of 11 KW and higher ratings employ automatic star delta starters. Starters shall be provided with three phase overload relays having thermal characteristics suitable for the associated motor and its starting characteristics and suitably compensated for ambient air temperature variation. In addition, provide single phasing protection. Means should also be inherent in the starter for automatically disconnecting the motor from the electricity supply in the event of interrupted supply or under voltage. Provide earth leakage protection for all motors.

D. Starters shall have in addition to the auxiliary contacts required for interlocks, alarms, BAS, and controls two additional sets of normally open and normally closed contacts.

E. Motor Protection against the short-circuit shall be achieved by motor circuit breakers of moulded case type and the combination with control-command devices (Breaker + Contactor + Overload relay) shall be of type 2 co-ordination as defined by the IEC standards 947-4.1. The type 2 co-ordination should be tested in laboratory and the manufacturer should guarantee the same by submitting the type-2 co-ordination tables. The co-ordination table shall indicate for each motor rating, the circuit breaker type and set up characteristics, the contactor type and the thermal relay type with its setting range.
The specifications mentioned in the MCCB's section is applicable for the breakers used in the motor protection. The moulded case circuit breakers used for motor protection shall be equipped with adjustable magnetic trip unit for short-circuit protection with settings from 6 to 14 times the nominal rating of the device.
The contactors used for Motor protection shall have contactor utilization category AC3 at 415V 50Hz as per IEC 947-4. Tripping class for overload relays used for motor protection shall be of one of the tripping class (class 10A, 10, 20, 30) as per IEC 947-4 depending on the motor starting characteristics.

F. For each starter, provide the following :

1. 1 set of 'ON' and 'OFF' push buttons for starting and stopping of motor.
2. Red and Green indicating lamps to show status of motor.

3. Suitably scaled ammeter with selector switch for each motor above 7.5 KW.
4. All auxiliary contacts for BAS.
5. Instruments for KW indication by BAS.

G. For each motor circuit, its associated circuit breaker and its starter shall be housed in one cell or unit and interlocked so that cell door cannot be opened and started unit cannot be withdrawn unless the breaker is in the 'OFF' position.

2.16 AUTOMATIC VOLTAGE STABILISER

Wherever specified/indicated, the stabilizer shall be constructed on booster transformer principle. The rating of the stabilizer shall be as indicated on drawings or as specified in the B.O.Q

Technical Requirements

Ambient Temp.	up to 50 °C
Cooling type	Natural air cooled
Input	415V AC ±15% at 50Hz
Output	415V AC±2% at 50 Hz

The stabilizer shall be equipped with filters for transients, compensator for unbalanced load in 3 phases, protection against faults and malfunctions. The stabilizer shall be fixed with 3 Ammeters, voltmeters

PART 3 – EXECUTION

3.01 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 upto 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 coloured 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 $2.5mm^2$ with PVC insulation to B.S. 6231. Small wiring shall be neatly bunched and cleated in harness form, or shall be enclosed in purpose made plastic trunking or troughing. Wiring cleated to metal surfaces shall be insulated from the metal. Where wiring runs through sheet steel panels, holes shall be grommeted with suitable grommets.

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

H. 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

3.02 FLEXIBLE CONDUITS

A. The final conduit/connections to motors or apparatus shall be in flexible conduits

*** END OF SECTION ***

SECTION 16500
LIGHTING SYSTEM

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. The work of this Division shall be governed by the following documents:
1. Conditions of Contract.
2. Instructions to Tenderers.
3. Form of Agreement.
4. General and Special Conditions of Contract.
5. Form of Tender.
6. Appendices.
7. Applicable Divisions.

B. Comply with requirements of Section 16010 electrical General Provisions.

C. It is the Contractors responsibility to be fully aware of and comply with all of the requirements of the above listed documents.

1.2 SCOPE OF WORK

A. Supply all labour, tools, services and equipment and provide all the materials required to complete this section of the work.

B. The lighting installation for this project shall consist of the following systems but shall not be limited to.
1. General lighting.
2. Emergency and exit lighting system as shown on drawings and luminaire schedule.
3. Exterior and site lighting.

C. Generally the lighting installation shall be carried out by installing conduits within the building structure and walls forming a flush installation in mechanical rooms, electrical switch rooms and other service areas the installation shall be on the surface.

D. Generally some of the lighting installation may be switched utilizing programmable low voltage switching.

E. Emergency lighting and exit signs shall be connected as shown on drawings.

F. External lighting shall be contactor controlled incorporating scheduled BMS or KNX lighting control system

1.3 QUALITY ASSURANCE

A. Acceptable Manufacturers.

1. Subject to compliance with the requirements of the Contract documents, acceptable manufacturers are to be firm regularly engaged in the manufacturer of lighting fixtures of similar quality whose products have been in satisfactory use under similar service conditions for not less than ten years.

1.4 SUBMITTALS

A. Reference Applicable Divisions – Submittals

B. Reference Applicable Divisions - shop drawings, products and data and samples.

C. Submit shop drawing of:

Each type of lighting fixture detailing.

i. Catalogue illustrations of luminaire proposed for each specified application.
ii. Design and installation requirements.
iii. Photometric curves and isolux diagrams for each luminaire with indication of minimum light output ratio.
iv. Date indicating each luminaire type's maximum and minimum ambient operating temperatures, and special features, where applicable to withstand onerous conditions, ie. High ambient temperature, intense direct sunlight blowing sand and grit, salt laden air etc.

Computer print out of exterior flood lighting of the building.

D. Samples and shop testing.

Fxture (Recessed type)

i. For the lighting fixture (recessed in F.C) the contractor shall obtain from he ceiling manufacturer a 3m x 3m sample of the ceiling assembly for the Jebsum F.C. The fixture manufacturer shall finalize the details and dimensions the fixture recessed to be co-ordinated with and accommodate the ceiling assembly.
ii. Inform the engineer fourteen (14) days in advance of the assembly being completed and obtain the consultant approval for the assembly.

E. Spares

Provide spare luminaires, control gear, lamps and louvres as listed hereinafter.
Luminaries : recessed type: 50 No.

Lamps

i. Provide 20% spare & tubes of each lamp & tube type and rating with a minimum of 10 lamps or tubes of each type and rating.

Control Gear

i. Provide 20% control gear of each control gear type and rating with a minimum of 10 control gear per type and rating.

Louvres & Lenses

i. Provide 5% spare lenses & louvres of each type.

Emergency conversion modules.

i. Provide 10% of each type with a minimum of 5 modules per type and rating.

1.5 DESIGN CRITERIA

Generally, all luminaires have been selected to achieve the underlisted illumination levels for the reflectance's of surfaces applicable, and a maintenance factor of 80% - 90%:

Location/Function	Min. Service Illuminance (LUX)
Archives	500
Conference Room	500
Corridors	100
Entrance Hall	400
Mechanical Plantroom	300
Meeting room	400
Offices	500
Public Areas	200
Pump Room	200
Stairs	200
Store	300
L.V. Room	300
Pantry	150
Toilets and lockers	200
Waiting Area	300
Lounge	250

Note: Max. Service illuminance shall not exceed 20% of the above levels.

PART 2-PRODUCTS

2.1 LUMINARIES - GENERAL

A. Standards

1. IEC Standard 61 - Lamp Caps and Holders.
2. IEC Standard 64 - Tungsten Filament Lamps.
3. IEC Standard 81 - Tubular Fluorescent Lamps.
4. IEC Standard 82 - Ballasts for Tubular Fluorescent lamps.
5. IEC Standard 155 - Starters for Fluorescent Lamps.
6. IEC Standard 188 - High Pressure Mercury Vapor Lamps.
7. IEC Standard 259 - Miscellaneous Lamps & Ballasts.
8. IEC Standard 598 - :luminaires, incorporating:
   Part 1: 598-1, General requirements and tests - 1979 including all subsequent amendments.

   Part 2: 598-2, Particular requirements including 598-2-1; fixed general purpose luminaires - 1979, 598-2-2; recessed luminaires - 1979, 598-2-5; Floodlighting – 1979, 598-2-19; Air handling luminaires - 1981, chain suspensions - 1982.

B. Equipment

1. Luminaires shall be completely self continued, unless otherwise specified, and include all control gear, lamp holders, reflectors and diffusers, as required.
2. Luminaires shall be recessed, surface-mounted or suspended as indicated on the Drawings, by code reference and identified in luminaire Schedule and Data sheets.
3. All diffusers shall be of the light stabilized and non-discoloring type.
4. The design, construction and finish of all luminaires shall be entirely adequate for operation in the ambient conditions and at the supply characteristics stated in section 16010 of this specification. All luminaires shall be designed and installed to permit easy relamping.
5. Where possible a terminal block shall be provided inside each luminaire and the wiring between this terminal block and lamp holders, choke, capacitors, etc., shall be completed in heat resistant (135^{o}C) cable of adequate size. Terminal blocks fixed to outside of luminaire housings shall be shrouded type with cable cord grip.
6. Where space is not available for the installation of a terminal block at the luminaire, a separate terminal block shall be provided in an adjacent junction box connected back to the luminaire in heat resistant (135^{o}C) cable of adequate size.
7. All luminaires shall be suitable for connection to rigid conduit, and/or flexible circular sheathed cable.

8. all weather-proof luminaires shall be fully suitable for outdoor use and shall not deteriorate after extended use in the ambient site conditions state.
9. All mounted luminaires shall be connected to the control box in heat resistant (135^{o}C) cable.

2.2 EXIT SIGNS

A. Shall be bilingual, details as shown in the following documents and to the approval of Civil Defense authorities:

- Signage and Graphics
- Luminaire Schedule

- Electrical Drawings
- Data Sheets included herein.

PART 3 EXECUTION

3.1 INSTALLATION GENERAL

A. Refer to Section 16010.

3.2 INSTALLATION OF LIGHTING FIXTURES AND LAMPS.

A. Provide all lighting fixtures and lamps shown on the drawings luminaires schedule and data sheets attached herein.

B. Include for assembly, and mounting of all fixtures, complete with all wiring, connections, fittings, hangers, aligners, box covers and accessories which may be required for any fixture to provide a complete, safe, fully operational assembly.

C. Generally, install fixtures in accordance with applicable reflected ceiling plans and/or as directed by the Architect. In equipment rooms, shafts and similar secondary areas, install fixtures after the mechanical and other major work is roughed-in and adjust fixture locations as required.

D. Thoroughly review all ceiling types, construction details and mounting arrangements before placing fixture orders and ensure that all mounting assemblies, frames, rings and similar features are included for and match the requires installation.

E. All fixtures and fixture assemblies shall be properly secured and supported. Support fixtures independent of the ceiling construction complete with all fasteners, framing and hangers. Do not secure fixtures to mechanical ductwork or other vibration producing apparatus unless specifically detailed on the drawings.

F. Where fixtures are suspended from the structure they shall utilize self aligning box covers with an additional ground wire from the outlet through the hanger for continuity of ground.

G. Carefully co-ordinate the fixture installation with the work of other trades ensuring that the necessary depths and mounting spaces are provided. Do not alter fixture locations unless approved by the Architect.

H. All lamps shall be new and intact when the project is complete, and ready for acceptance.

I. Provide safety chains on all surface mounted or suspended fixtures.

J. The final connection to all luminaries integrated into suspended ceilings shall be by means of flexible heat resisting cable terminated at a plug and sockets ceiling rose mounted in the ceiling void directly adjacent to the luminaire. All such ceiling roses shall be appropriately rated to suit the rating of the associated sub-circuit protective device. The plug and socket ceiling rose shall be located directly above or adjacent (within a horizontal distance of 1.5m from the centre of the fixture) at the side of luminaire such that it is readily accessible for disconnection and maintenance.

K. Earthing

1. All luminaries of metallic construction shall be suitably earthed, the earth wiring being connected by a terminal provided within each fitting specifically for this purpose.

2. Where luminaires are suspended, a cable protective conductor shall be connected between the fitting and the final sub-circuit wiring installation.

L. Luminaires Commissioning and Testing

1. At the discretion of the Engineer, make-up site test and demonstrate the operation of special application of fixtures such as building floodlights, landscape fixtures and other decorative fixtures, and adjust their locations within a reasonable distance to obtain the effects desired to the approval of the Architect. Assist in the aligning and positioning of all adjustable fixtures, and ensure that fixtures with adjustable lamp holders are properly positioned to correspond with the lamps specified.

3.3 EXIT SIGNS

A. Provide all Exit Signs as scheduled and shown on the drawings, signage and graphics document and luminaire schedule.

B. Directional arrows on Exit lights shall be as shown on drawings and in accordance with local Civil Defense Department requirements.

***** END OF SECTION ****

SECTION 16640
EARTHING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Grounding System including, but not limited to the following:

1. Grounding rods.
2. Grounding conductors.
3. Grounding connection bar.
4. Grounding of various systems.

1.02 RELATED SECTIONS

A. Electrical Works, General.

B. Electrical Identification.

C. LV Cables and Wires.

D. Underground Electrical Services.

1.03 REFERENCES

A. British Standard Code of Practice CP1013 - Grounding.

B. BS 7671 IEE Wiring Regulations, 16th Edition.

1.04 SUBMITTALS

A. Submit manufacturer’s data, illustrated leaflets, dimensions, fixing details and description of the proposed products.

1.05 QUALITY ASSURANCE

A. Manufacturer's: Firms regularly engaged in the manufacture of Grounding equipment, whose products have been in satisfactory use in similar service for not less than 10 years. Preference shall be given to local manufacturers and suppliers/agents.

B. All equipment furnished under these Specifications shall conform to the requirements of BS, IEC and Local Standards Organization.

1.06 DELIVERY, STORAGE AND HANDLING

All products shall be carefully packed to avoid damage during transportation.

PART 2 PRODUCTS

2.01 GENERAL

A. All the materials required for Grounding system shall be furnished new and undamaged in accordance with the requirement stated in this section.

B. Conduct soil electrical resistively tests at four locations (minimum) advised by the Engineer. The Grounding calculations based on the test results shall be submitted for Engineers approval, to demonstrate that the proposed design of Grounding system complies with the specifications and standards.

C. For High voltage equipment in Transformer room, a connection shall be provided from the main Grounding loop. Also Grounding pits shall be installed as per Local Electric Supplier

requirements, which will be isolated from the main Grounding loop.

D. For communication room, separate Grounding pits shall be installed as per Local Telephone Supplier requirements, which will be isolated from the main Grounding loop.

2.02 Grounding connection bar

A. For connection of MV and LV equipment, sub-station shall have high conductivity copper, Grounding connection bar with minimum dimensions of 50 x 6 mm and mounted on porcelain insulators. The bar shall be of suitable length with pre-drilled holes at a minimum distance of 50 mm between hole centres.

B. Grounding connection bars for transformer neutral and LV switchboard frame shall be separate from Grounding bar for HV and transformer frame.

C. Each Grounding connection bar shall have a permanent label to identify the connections together with the wording "Main Grounding Bar".

PART 3 EXECUTION

3.01 INSPECTION

A. Examine the area and conditions under which the Grounding systems are to be installed and correct any unsatisfactory conditions detrimental to the timely and proper completion of the work. Do not proceed with the work until the conditions are satisfactory in a manner acceptable to the Engineer.

3.02 GROUNDING CONDUCTORS INSTALLATION

A. Standard sizes of stranded copper conductor used for Grounding continuity shall be according to the requirements of IEE Wiring Regulations, 16th Edition..

B. Suitable Grounding facilities, acceptable to the Engineer, shall be furnished on electrical equipment to consist of compression type terminal connectors bolted to the equipment frame or enclosure and providing a minimum of joint resistance.

C. The conduit system shall not be considered as continuous for Grounding purposes. A separate Grounding conductor shall be installed in the same conduit with the phase and neutral conductors. The separate Grounding conductors shall be sized according to IEE Wiring Regulations, 16th Edition. requirements. No Grounding conductors shall be smaller than 2.5 mm2 unless this is part of a multicore cable. Where flexible connections are made to equipment, Grounding jumpers shall be provided. All connections of heavy gauge steel conduit system shall be checked for good electrical continuity.

D. Exposed conductors shall be installed inconspicuously in vertical or horizontal positions on supporting structures. When located on irregular supporting surfaces or equipment, the conductors shall run parallel to or normal to the dominant surface.

E. Conductors routed over concrete, steel or equipment surfaces shall be kept in close contact with those surfaces by using fasteners located at intervals not exceeding 1 m.

F. Exposed Grounding conductors shall be securely fastened to the mounting surface using copper or brass straps.

G. Clamps, connectors, bolts, washers, nuts and other hardware for bolted connection to Grounding system shall be of copper.

H. Exothermic welds shall comprise moulds, cartridges, materials, and accessories as recommended by the manufacturer.

I. The Grounding conductors entering the building shall be installed in a 25 mm diameter PVC conduit. Waterproofing shall be provided at all entry of Grounding conductors, details of which shall be approved by the structural engineer.

J. Grounding conductors shall be buried at a minimum depth of 750 mm below finished grade.

K. Underground conductors shall be buried in clean sifted Grounding.

L. Except for sub-stations and electric rooms, the exposed Grounding conductor shall run in protective pipes for runs below 900 mm from floor level. Pipe shall also be provided at locations where conduct is likely to be subject to physical damage.

M. Extensions from Grounding loop as shown on the Drawings shall be provided for connection to electrical equipment. Connect the Grounding conductor to the equipment, Grounding bus, pad or lug. In addition to the Grounding grid extension conductors, an Grounding cable to each end of the Grounding bus in each assembly of power distribution board or panel boards shall be provided.

N. Where an Grounding conductor is included with the phase conductors of power circuits, the Grounding conductor shall be connected to the equipment Grounding facilities and to the source Grounding bus. Where an grounding conductor is not included with the phase conductors, the equipment shall be Grounded by connecting a separate Grounding cable to the equipment Grounding facilities and to the tray Grounding cable or source Grounding bus. Except where otherwise shown on the Drawings, integral parts of a cable assembly shall be sized in accordance with the requirements of IEE Wiring Regulations, 16th Edition.

3.03 BUILDING SYSTEMS GROUNDING

A. The building low current systems including communication, control and alarm functions…etc shall be provided with Grounding as shown on the Drawings and in relevant specifications.

B. The installation of the Grounding for building systems shall be in accordance with the recommendations of standards, and the applicable provisions of this section.

3.04 SUPPLEMENTARY AND EQUI-POTENTIAL BONDING

A. In accordance with Section 547 of the IEE Wiring Regulations 16th edition (BS 7671) bonding conductors shall be installed in appropriate locations to ensure all simultaneously accessible exposed or extraneous conductive parts are at equal potential. Undertake such tests and install such supplementary bonding conductors that are necessary to ensure compliance with these requirements.

B. Supplementary bonding conductors shall conform to the requirements of Section 547-03 of the IEE Wiring Regulations and shall have a minimum cross-sectional area of 2.5 mm2 where mechanically protected and 4.0 mm2 where not so protected.

C. Main equi-potential bonding conductors shall conform to the requirements of Section 547-2 of the IEE Wiring Regulations and shall have a minimum cross-sectional area of 6.0 mm2.

3.08 FIELD QUALITY CONTROL

A. Grounding resistance tests shall be carried out after installation of the individual Grounding systems in accordance with the Specifications. The Grounding resistance tests shall be carried out in accordance with Section 713-11 of the IEE Wiring

Regulations 16th edition and readings obtained officially recorded by all witnessing parties.

C. Prior to connection of Grounding rods to the Grounding system, the Grounding resistance of individual Grounding rod shall be measured by using an approved type of Grounding resistance tester.

D. After completion of all the connections of Grounding system, the Grounding resistance shall be measured from the Grounding test point in presence of the Engineer.

E. All the Grounding resistance test reports shall be submitted for Engineer's approval.

The presence of the electrode shall be indicated in English and Arabic.

****** END OF SECTION ******

SECTION - 16720
FIRE DETECTION AND ALARM SYSTEM

PART 1 GENERAL

1.01 The contractor shall be responsible for the supply, installation, commissioning and servicing of the Analogue addressable fire alarm system.

1.02 The contractor must review the consultant's proposal for suitability to his system. All deviations should be brought to the notice of the Engineer.

1.03 The contractor or his representative must have, at least, 10 years experience in installing, commissioning and servicing fire detection and alarm systems, at least 5 of which must be with analogue addressable systems.

1.04 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:

1. Fire Alarm Control Panel
2. Repeat Panels
3. Addressable ancillary equipment,
4. Power supplies, and automatic point detection equipment.

1.05 The manufacturer shall be approved to BS5750 part 1 Quality system standard for the design and manufacture of the equipment referred to in clause 1.5 (ISO).

1.06 The main equipment proposed for use shall be approved by at least one of the following:

1. Loss Prevention Council (LPC)
2. Underwriters Laboratories (UL)
3. Association of German Prosperities insurance company (VDS)

1.07 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.

1.08 The manufacturer, given reasonable notice, shall permit the buyer, or its nominated agent, to conduct a quality audit at the premises where the proposed equipment is manufactured.

1.09 All deviations from this specification that the contractor proposes to make shall be clearly indicated in writing, referring to the relevant paragraph(s) of this specification.

1.10 The system offered shall be approved by the concerned local authorities Fire department and any changes in equipment, materials shall be incorporated at no extra cost.

1.11 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.

1.12 OUTPUT SIGNALS UNDER FIRE CONDITIONDS

A. Provision shall be made in the Fire Alarm Control Panel to provide the following:

1. Potential free NO/NC contacts or interface as required for the fire doors & Elevators.
2. Potential free NO/NC contacts or interface as required for shutting or starting Mechanical/HVAC equipment such as AHUs, Pumps, Dampers, Fans etc as may be required.

B. The Electrical contractor shall be responsible for providing conduiting and wiring from the fire alarm control panel up to the required equipment(s) as mentioned in paragraph ‘A’ above.

1.13 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 the 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.

1.14 APPROVALS FROM THE CONCERNED LOCAL AUTHORITIES (i.e. CIVIL DEFENSE FIRE DEPARTMENT)

A. Before commencing any installation works, the contractor shall obtain 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 Fire department during and after the installation as deemed necessary and as required.

1.15 SCOPE OF WORK

A 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 Fire department Regulations.

B Contractor shall install smoke detectors above false ceiling and also where false ceiling depth is 80 cms and above within contract price.

C The electronically operated analogue addressable system including but not limited to the following items.

1. Fire Alarm Control Panel.
2. Fire Alarm Repeater panels (When indicated in drawings)
3. Power supply and standby batteries with charger.
4. Smoke Sensors
5. Sensor Sounders
6. Heat Sensors
7. Beam Sensors
8. Duct Sensors
9. Manual Call points
10. Audio Visual Alarms
11. Alarm Sounders
12. Interface units
13. System interface with Main fire alarm panel (Where indicated)
14. System interface with fire fighting system (Sprinkler, Fire extinguishing System)
15. System interface with Air handling units
16. System interface with Elevators
17. System interface with Smoke and fresh air fans
18. System interface with Building Management system.
19. System interface with ATS
20. System interface with Smoke doors
21. Printers
22. System interface with other specified systems like Access Control etc.

1.16 Any additional ductwork, encasement works required shall be the responsibility of the electrical contractor. He shall not be entitled for any additional claims on these accounts.

1.17 It is assumed that the contractor before signing the contract has surveyed the site and ascertained the routes and hurdles.

1.18 RELATED WORKS

A Section 16120 Conduits

B Section 16110 Raceways

C Section 16200 Cables & Wires

D Section 16300 Supporting Devices

1.19 SUBMITTALS

A Shop drawings showing complete details.

B Manufacturer's detailed instructions

C Submit all shop floor and other relevant drawings to the concerned local authorities Fire department and obtain necessary approvals.

PART 2 PRODUCTS

2.01 CONTROL AND INDICATING EQUIPMENT

A **The Fire Alarm Control Panel** (F.A.C.P) shall be the central processing unit of the system, receiving and analyzing signals from fire sensors, providing audible and visual information to the user, initiating automatic alarm response sequences and providing the means by which the user interacts with the system.

B System shall be true Analogue with the ability to print the output from a fire sensor over a period of time

C The (F.A.C.P) shall be modular in construction allowing for future extension of the system.

D The (F.A.C.P) shall be able to be easily configured to meet the exact detection zone and output mapping requirements of the building considered.

E The (F.A.C.P) shall be microprocessor based and operate under a multitasking software program. Operating programs and configuration data must be contained in easily up-datable non-volatile memory (EEPROM).

F All devices i.e., Optical sensors, Heat sensors, Duct and Beam Sensors, Fire Alarm Interface units, Electronic Sounders, Manual Call Points etc, shall appear their addresses on visual display unit of the panel on request.

G All devices shall be assigned a maximum of 32-character alphanumerical label. Incase of fire, fault or alarming, the label of devices sensing threshold shall appear on visual display unit of the panel.

H The (F.A.C.P) shall meet the requirements of BS5839 Part 4 or NFPA 72 and shall be approved, together with associated ancillary equipment, by the Loss Prevention Council (LPC), (UL) or (VDS).

I No more than 254 addressable input Devices shall be controlled by a single Loop processor card.

2.02 SYSTEM DESCRIPTION

A The (F.A.C.P) Shall be capable of operating with any of the following types of automatic detection equipment:

- Conventional detectors
- Analogue addressable sensors.

B The (F.A.C.P) shall be capable of operating with conventional detectors and analogue addressable detectors suitable for installation in hazardous areas.

C Analogue Addressable devices shall be connected to loops capable of accepting up to 254 devices per loop.

D The (F.A.C.P) shall have a minimum capacity for operating 1 fully loaded addressable loop. This shall be extendible to 32-loops.

E Provision shall be made for each addressable loop to be sub-divided into a geographical zones. The section of wiring corresponding to each zone circuit shall be protected from faults by means of line isolator modules (built-into the detector or by means of using isolator base).

F It shall be possible to allocate all 254 addressable devices per loop.

G The (F.A.C.P) shall have provision to drive and monitor repeater panels providing a repeat of the indications on the (F.A.C.P) display.

K. The system shall have two addressing methods:

1. Software addressing.
2. Hardware addressing.

2.03 MONITORING AND CHECKING CIRCUITS AND FAULT CONDITIONS

Facilities shall be provided to constantly monitor and check the following circuits and fault conditions.

A The power supply on the loops

B For open circuit, short-circuit, earth fault and any other fault condition in any segment in the loop wiring.

C For communication failure and errors in all cord and loops.

D For faults in Keyboard and printer circuits.

E Monitoring of all devices status.

F Provision shall be done at the fire alarm control panels to silence the loop powered alarm sounders but the visual indication shall remain until the system is reset.

G It shall be possible to change the sensitivity of analogue sensors from the Fire Alarm Control panel only.

2.04 BASIC SYSTEM FUNCTIONS

A The (F.A.C.P) shall monitor the status of all devices on the Addressable loops for fire, short-circuit fault, open-circuit fault, incorrect addressing, unauthorized device removal or exchange, pre-alarm condition and contaminated sensor detector condition.

B In the event of a fire being reported from the smoke/heat detectors, activation of manual call points or sprinkler operation the sequence of alarm operation shall be as follows:

C If fire condition is reported from a sensor area this should cause a fire signal to be reported at the control panel. The system should incorporate approved delay time and if the alarm is not acknowledged in this period, the evacuation message should be broadcast through the speakers automatically to the affected floor plus the floor above and below. The alert signal to other floors shall be as previously described.

D If a Manual Break Glass Unit is activated or a sprinkler flow switch is operated, then the evacuation shall be transmitted immediately to the affected floor plus the zones required by engineer or the owner. The signal to the other zones shall be as previously described.

E In each of the above cases, upon initiation of an evacuation signal all the electronic sounders in areas such as plant rooms and emergency staircase shall operate immediately. The signals shall not discriminate with floors.

F Activation of the fire alarm system shall directly initiate some or all of the following to be agreed as part of the overall engineering policy.

1. Signal to all elevator machine rooms indicating fire status (to control lifts)
2. Release doors normally locked by magnetic devices.
3. Release doors normally held open by magnetic devices.
4. Shutdown mechanical equipment ventilation plant.
5. Shutdown general exhaust fans.
6. Start up smoke extract fans.
7. Start up exhaust makes up fans.
8. Start up stair vestibule pressurization fans.
9. Automatically operate fire dampers.
10. Initiate alert signals in all panels.

G Supervised by the fire alarm system in Main building

2.05 MAIN FIRE ALARM CONTROL PANEL

A The panel shall be computer controlled using analogue technique to detect smoke/ heat /fire conditions. The panel shall be complete with, but not limited to, the following elements:

B 5.7” touch screen display unit adapted to customer-specific needs.

C Integral sealed lead acid battery and charger, with 24-hour back up in the event of supply mains failure.

D Essential control-sound alarms, silence alarms and reset fire. These shall be enabled by a key switch.

E Cancel fault buzzer.

F Fire, fault, warning and power on lamps.

G Simple menu driven function keys with password protection shall configured in the touch screen shall allow users to an extensive range of software-based features such as:

1. Last 150 fire and trouble events minimum
2. Current fault and warning logs
3. Analysis of analogue sensor information
4. Interrogation of sensor cleanliness

5. Enable/disable sensors, zones, sounders, interface, unit channels
6. Fire plan configuration menus
7. Outstation label changes
8. Address allocation
9. Status of outstation
10. Status of all cards
11. Printer on off, line feed and test facilities
12. Address allocation

H Up to 254-device capacity per loop.

J RS 232 /RS 485 computer communication option.

K In addition to the above, all other necessary control, elements and accessories shall be included to provide a complete and efficient panel confirming to the requirements of BS or NFPA.

2.06 SMOKE SENSORS

A These shall of addressable optical type with built-in isolator in a single head. The optical element shall monitor for visible smoke from slow smoldering fires. Smoke sensing design shall comply with BS 5445: part 7 and shall be LPCB approved or comply with NFPA – 72 and shall be UL approved or VDS approved.

B All smoke sensors shall comprise of three components.

1. Termination Plate, Electronic Module and replaceable sensor chamber. The termination plate shall incorporate the terminals for wiring. The electronic module shall plug-on onto the termination plate as a second fix item all electronic components and circuitry suitable for an Analogue addressable system.
2. This design shall allow sensing element alone to be replaced, should it become dirty almost dirty, excessively dirty, due to a build up of dust from the surrounding atmosphere. When removed, the panel shall display a fault condition with a message “Sensor chamber Removed” with a relevant label/address. The sensor chamber shall also have viewing LED indicator.
3. Sensors mounted in the false ceilings may be provided with semi flush mounting kits if it is required by the engineer.

2.08 HEAT SENSORS

A These shall comply with the requirements of BS 5445: Part 5: 1977 and shall be LPCB approved or comply with NFPA-72 and shall be UL listed or VDS approved. They shall be complete with other elements described for smoke sensors above, for an analogue safe addressable sensing device.

B Sensors mounted in the false ceilings may be provided with a semi flush mounting kits if it is required.

2.09 BEAM SENSORS

A The Beam Sensors shall detect fire by obscuration of an optical beam by smoke. It shall utilize a transmitter and receiver unit. It shall be used in areas as indicated in the drawings.

B The Beam sensors shall be LPCB or UL approved and to BS 5839 Part 5 or NFPA-72 or VDS approved.

2.10 DUCT SENSORS

Duct Sensors shall be safe addressed, loop powered, loop signaled. They shall comprise of a sampling unit with probes extending into a straight section of the mechanical ventilation ductwork. The duct sensor shall comprise of Optical Smoke/ Sensing devices.

2.11 CALL POINT

These shall comply with the requirements of BS 5839: part 2: 1983 or NFPA-72, and shall be complete with all-electronic components and circuitry for an addressable device. Polycarbonate cover type option shall also be provided if required. The unit shall incorporate glass to broken. The electronic circuitry shall have built-in line isolator.

2.12 ALARM SOUNDERS

A The addressable Alarm Sounders shall be sited in areas as shown in the schematics and the floor layout drawings. The sounders shall be configured via software to operate individually or in sectored groups; totally independent of the way they have been connected to the loops. The sounders shall have the synchronization feature to ensure that all the sounders give alert and evacuate tones that are totally in phase. Conventional Sounders that “free-run” and therefore be out phase with each other will not be accepted.

B The Sounders shall comply with BS, NFPA or VDS requirements.

2.13 INTERFACE UNITS

These shall be used to interface with the fire/fault signals emanating from the local control conventional (zonal) fire alarm control panels. These units shall also give/accept contact from other services required to be interfaced with fire alarm system with feedback ability e.g. Interfacing with AHU’s BMS, Elevators, Pressurization Fans etc. It shall be installed of addressable type with all inputs and outputs are to be fully monitored for cable faults. Power Supply units if required, with the interface shall also be monitored for any faults.

2.14 REPEAT PANEL

A The Repeat Panel shall be sites at the indicated locations. It shall consist of 5.7” touch screen for displaying and control. It shall provide system repeat facilities to repeat all the messages that appear on the main touch screen as well as the common indications. It shall have essential alarm controls and menu facilities.

PART 3 EXECUTION

3.01 INSTALLATION

A Fire alarm components shall be installed directly to conduit outlet boxes at the following mounting height above finished floor level, measured to the center of box unless stated otherwise.

B Fix manual call station semi-recessed at 1.50m heights above finished floor.

C Automatic smoke and heat Sensors: Ceiling Mounted/Surface Mounted/ Above ceiling mounted

D Alarm Sounders: 2.20m above finished floor.

E Outdoors alarms fix where indicated by the concerned local authorities Fire department and approved by the Engineer.

3.02 TESTING AND COMMISSIONING

A After the installation is complete, the Contractor shall conduct operating and commissioning tests. The equipment shall be demonstrated to operate in accordance with the requirements of the specification. The system installation, testing and commissioning shall be as per the concerned local authorities Fire department approval and requirements.

B The Fire Alarm Systems shall be complete programmed in accordance with the concerned local authorities Fire department Requirements and as specialist from the manufacturer shall attend and demonstrate the complete system.

C Fire Brigade and testing shall be the Contractor’s responsibility and the Contractors shall do any requirements for approval and handing over the Fire Alarm Installation without the extra payment even in time.

D Drawing and specification are complementary each to the other.

E. The “CODE FOR THE SYSTEM OPERATION” shall be handed over to the Client at the completion of the maintenance period.

3.03 Shall co-ordinate with other trades for the installation of the system.

3.04 The contractor /sub-contractor will be responsible for providing all access equipment necessary to enable safe installation of the system.

3.05 The Contractor shall provide necessary training to Client’s personnel to give them on job training, instructions etc. for proper operating and maintenance of the system.

3.06 The contractor will repair, correct or replace any defect of any nature that may occur for a period of 2 years from the date of issue of the certification of Completion.

3.07 Contractor shall provide a full set of manuals and operating instructions (service manual). It shall include descriptive brochures, technical manuals for all equipments forming part of the contract.

3.08 SPARES & TOOLS

Contractor shall provide manufacturers recommended spares / tools at the time of completion of the project for the use of the client. These spares / tools are not to be used by the contractor during the period of 2 years of maintenance.

*** END OF SECTION ***

SECTION 16760
DATA SYSTEM

Telecommunications Standards

The following standards apply to network & Telecommunications works:

1. ANSI/TIA/EIA-568-B-1: Commercial Building Telecommunications Cabling Standard Part 1: General Requirements
2. ANSI/TIA/EIA-568-B-2: Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling Components
3. ANSI/TIA/EIA-569: Commercial Building Standard for Telecommunications Pathways and Spaces
4. ANSI/TIA/EIA-758: Customer-owned Outside Plant Telecommunications Infrastructure Standard
5. ANSI/TIA/EIA-J-STD-607-A: Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
6. ANSI/TIA/EIA-606-A: Administration Standard for the Telecommunications Infrastructure of Commercial Buildings

PART 1 GENERAL

1.01 GENERAL

A The data System shall comprise of Supply, installation, testing & documentation for a category 6A cabling for the mentioned project provisional.

B Separate raceways shall be used for the data system.

C All runs of raceways shall be accessible for modifications or maintenance.

D Any additional ductwork, encasement works /raceways required shall be the responsibility of the electrical contractor. He shall not be entitled for any additional claims on these accounts.

E It is assumed that the contractor before signing the contract has surveyed the site and ascertained the routes and hurdles.

F The certified installer will be fully responsible on quality of service and warranty certificate to be submitted directly for the contractor under engineer supervision.

1.02 SCOPE OF WORK

The contractor shall supply, install and commission as provisional items first fix of the data System as ONE package, having the following as a minimum:

- Computer cabling cabinets
- Data Outlet with RJ45 Sockets Category 6A/type 3M
- Category 6A cables
- Raceways, trunking, conduits etc
- All other components, accessories required to complete the first fix Data system.

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.

1.03 CONTRACTOR OBLIGATIONS & QUALIFICATIONS:

The contractor shall carefully examine all of the specifications to ensure that he is fully conversant therewith & has included for everything necessary therein, either expressly provided for or as would normally be expected to be provided for by a reputable specializing in the type & nature of the services Described In The Contract.

The contractor is advised that items or matters not specifically provided for, or partially described or otherwise missing from the specifications, but which are nevertheless necessary for the execution & completion of the services, shall be deemed to have been included by the contractor.

Authorized & certified installers registered with their respective manufacturers with trained & certified engineers shall execute the installation of the cabling system.

The contractor shall carry out all the necessary surveys, design & engineering so as to provide for the services, a whole & complete system to ensure full compatibility of the services with any existing facilities pertinent to the cabling system applications/operations.

The scope of the services include the provision of all material, labor, supervision, construction, equipment, tools, temporary, spares, consumable & all other things & services required to engineer, design, supply, install, test & commission the cabling system.

1.04 EQUIPMENT & MATERIAL

All equipment, material & the like shall be such so as to withstand the prevailing climatic conditions in the state of Jordan & within the parameters of an ambient temperature varying from zero (0) to plus fifty five (55) degrees centigrade & a maximum relative humidity of one hundred percent (100%).

1.05 TESTING & COMMISSIONING

Acceptance testing shall be carried out by the contractor & witnessed by the owner personnel. The contractor shall provide all necessary instruments & accessories required to perform the testing.

1.06 WARRANTY

The system supplier shall warrant to repair or replace & make good at its expense any material found defective during a period of fifteen years from the date of the acceptance certificate.

1.07 RELATED SECTIONS

A.	Section 16110	Raceways
B.	Section 16120	Conduits
C.	Section 16300	Supporting devices
D.	Section 16200	Cables & wires

1.08 The specification and BOQ for the data system are for the guidelines of the contractor for the purpose of bidding. The contractor shall include all material and devices though not indicated but required for the proper and efficient installation of the system.

<u>PART 2 PRODUCT</u>

2.01 DATA BACKBONE

Technical specifications:

2.1.1 FTP CAT6A (4 PAIRS) CABLES

Installation cables category 6A, Enhanced, FTP
The pair-shielded 100ohm installation cables are suitable for voice, and data transmission at frequencies of up to 250 MHz. Dimensions: 4 x 2 x 0.58mm.

Cable construction

Sheath Material	Color	Conductor Diameter (mm)	Insulation Diameter (mm)
LSOH	Grey, RAL 7035	0.58	1.04 PE

Cable Properties

Bending

Minimum bending radius, installation 8 x D

Minimum bending radius, installed 4 x D

Tensile Strength

Maximum tensile load, installation (N) 100

Maximum tensile load, installed No stretch

Temperature Range

Operation (ºC) –20 to +60

Installation (ºC) 0 to +50

Fire Classifications:

PVC : IEC 60332-1

LSOH: IEC 61034, IEC 60754-1, IEC 60332-1

Heat Release

LSOH (MJ/km) 1030

Electrical characteristics 20 C

Characteristic impedance (4<f<100 MHz):100±15

DC-loop resistance (Î/km)

Resistance unbalanced, max (%)2

Optical braid overage (%)41

Transfer impedance, IEC 96-1

1 MHz (Î/m) 5

10 MHz (Î/m) 10

Nominal velocity of propagation (NVP)c 0.75

Mutual capacitance, nominal (pF/m) 48

Capacitance unbalanced, max. (pF/m) 1000

2.1.2 FTP RJ45/3M CONNECTION MODULES (FOR DATA)

The Cat. 6A connection modules are the connection modules that comply with the latest standard proposals of the international standardization bodies. They are the center piece in the realization of class E channels with up to 4 connection modules. Comply with the cat.6A components requirements of the latest standard proposals of ISO/IEC.

- Conform to Cat.6 requirements according to the EIA/TIA.
- 10dB better Next values with 100MHz
- Best transmission properties with freenet Cat.6 patch cords (R302298-R302341)
- Backwards compatible with Cat.5e and Cat.5.
- Fits into all freenet patch panels and outlets.
- Tool-free connection technique (IDC) for data cables with AWG 22-24 wire diameter.

- Allows opto-mechanical control of the connection technique.
- Error-free connection according to EIA/TIA 568A/B without pair crossover thanks to labeled wiring.
- Simple and time-saving shield contacting with integrated cable strain relief.
- Halogen-free material.
- 3P,UL,cUL certified
- Certificates available.

Electric and Transmission Data
Contact resistance < 50 milliohm (conductor - conductor)
Contact resistance < 20 milliohm (shield - shield)
Insulation resistance > 500 mega ohm (500 VDC)
Dielectric strength 1000 Veff. 50 Hz/1 min (conductor - conductor)
Dielectric strength 1500 Veff, 50 Hz/1 min (conductor - shield)
Coupling resistance IEC 96-1
1 MHz < 15 milliohm
10MHz< 100 milliohm

Mechanical Data
Material Polycarbonate, (UL 94V-0)
Mating cycles > 1000
Wire diameter 0.5 mm (AWG 24} - 0.65 mm (AWG 22)
Insulation diameter 0.8 - 1.6 mm
Mating cycles > 100
Wire strain relief Through labyrinth in IDC block
Cable strain relief Through cable ties
Shield contacting 1
Large surface contact springs (on plug)

2.1.3 DUAL FACE PLATES:

The free net dual modular outlets (voice/Data) and connection modules combine in various ways. The outlets accommodate a vast range of modules:
For optical wave guides, RJ45. ISDN or analogue telephony. The modules can be linked together in a single outlet and exchanged simply without any need for tools.
To ensure a clearer distinction, individual outlets at the workstation and on the Global Rack can be mechanically and color coded.
For greater safety in the event of fire, plastic outlets manufactured to fire category VO. Cat. 5e can be fitted to Cat. 6A
Modules on the same outlet, ensuring an easy switch to a higher category - another free net plus!

2.1.4 TRUNKS

Plastic trunks with different sizes should contain all the exposed cabling installation (if any).

PART 3 EXECUTION

3.1 All installation work shall be as per Data Transmission rules and regulations. Where no regulation is available, IEE wiring regulation shall be followed.

3.2 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 bridges, taps & splices. Cabling shall be as per ISO /IEC IS11801 Standards.

3.3 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.

3.4 Cables shall be laid with bend radii and maximum pull through forces as per manufacturer's standards.

3.5 Conduit and ceiling distribution shall be according to EIA/TIA 569 standards

3.6 Drawing and specification are complementary each to the other.

3.7 Shall co-ordinate with other trades for the installation of the system.

3.8 The contractor /sub-contractor will be responsible for providing all access equipment necessary to enable safe installation of the system.

3.9 Outlets shall be atleast 25cm distance from nearest electrical point.

3.10 Nodes shall be tested using scanner for category 6 outlets. The test shall be performed in the presence of the engineer after termination.

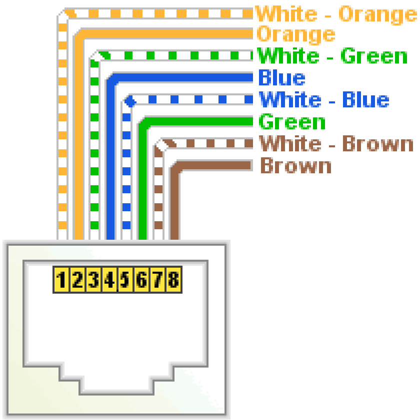
3.11 Both ends of the cable shall be labeled for identification.

3.12 Detailed cable routing diagram must be produced for installation. This shall be reference for future maintenance, expansion, fault tracing etc.

3.13 Contractor shall provide a full set of manuals and operating instructions. It shall include descriptive brochures, technical manuals for all equipments forming part of the contract.

4.4 Network cabling specification

All Cables provided must be of Category 6 Unshielded Twisted Pair (UTP) type and terminated to 568B Wiring Scheme. It is essential that the same wiring scheme is followed for the whole wiring network.



RJ-45 Socket
(568B wiring scheme)

Pin Number	Wire Colour	
1.	White - Orange	
2.	Orange	
3.	White Green	
4.	Blue	
5.	Blue White	
6.	Green	
7.	White Brown	
8.	Brown	

Fig2. EIA/TIA 568B Network Wiring Scheme

All cable runs must terminate on patches in the server room on the Ground floor for both voice and data connections.
All cable runs must be either in trunking/conduit or secured onto data basket/tray.
All cables must be installed to avoid bearing on sharp edges or frictional overheating.
Cable sheaths and jackets must not be damaged during installation.
Cables must be protected where they pass through holes in walls or ceilings.
Cable ties must be used and tightened to comfortably hold but not constrain the outer sheath of the cable to cable basket/tray.

Cables entering the network cabinets should be securely tied to the cable tray within the cabinets, and tied and loomed neatly after termination on the patches.
Cable should not be attached directly to the cabinet stanchions.
No cable runs should be longer than 90 metres. It shall be the sole responsibility of the contractor to visit the site, measure all proposed containment runs and detail in writing to the Project manager all runs of cabling that will exceed 90 metres, or give written confirmation that all runs are within 90 metres. No installation cabling is to be undertaken until one of the above has been confirmed.

4.5 Trunking

- All trunking must be 3-part compartmentalised & Category 6 compliant.
- All bends, tees and crossovers should be gusseted to allow for adequate bend radii of the installed cables.
- All trunking needs to be of sufficient capacity to allow for the minimum bend radii of the copper cables.

4.6 Labelling

-

- All cable drops must be properly labelled at the workstation area and at the patch panel area in the Server room.
- Labels must be on plates, sockets and on cable in two sides
- The labels must be machine printed. Handwritten labels will not be accepted.
- The labelling schema of the outlet faceplates will be obtained from the ENGINEER office according to ANSI/TIA/EIA-606-A
- **<u>Labeling the cables</u>:**
  - Special Label must be located on 30cm at the end of the cable show where the path of the cable.
  - Examples:
    - In the side of the patch panel the label show the floor, department and socket Number that belong to.
    - In the side of the socket the label show the patch panel and port Number.

5.3 Verification and Testing

All cable drops must be tested for proper wire mapping.
Category 6 UTP cable testing will test each conductor for end-to-end continuity.

Each cable must be tested for correct termination on a pin-by-pin basis.
Each station must be tested with a Category 6 Fluke tester to verify compliance with EIA/TIA - 568B colour coding and pin numbering specifications.

Should any cable fail to meet the Category 6 standards outlined above, the contractor will be responsible for rectifying the fault, either by re-termination of the cable or by re-running the complete cable if necessary. In either case, the cable must be re-tested to ensure that the rectified cable meets the Category 6 standards.

8.2 Contractor Responsibilities:

- Providing all supervision, labour, tools, equipment, materials, transportation, erection, construction, unloading, inspection and inventory housing.

- Obtaining ENGINEER’s permission before proceeding with any work necessitating cutting into or through any part of the building structure such as beams, concrete, tile floors or partition ceilings.

- Promptly repairing all damage to the building due to carelessness of contractor employees and exercising reasonable care to avoid any damage to the building. Reporting to ENGINEER any damage to the building that may exist or may occur during the contractor’s occupancy of the building.

- Taking necessary steps to ensure that required fire fighting apparatus is accessible at all times. Flammable materials shall be kept in suitable places outside the building.

- Installing the wire, cable and hardware in accordance with EIA/TIA specifications.
- Conducting tests and inspections as specified post-installation.

- Promptly correcting all defects for which the contractor is responsible as determined by ENGINEER.

- Removing all tools, equipment, rubbish and debris from the premises and leaving the premises clean and neat upon completion of the work.

- Abiding by the safety and security rules on the work site at all times.

- Following industry standard installation practices.

***** END OF SECTION *****

SECTION 16771
PUBLIC ADDRESS / VOICE ALARM SYSTEM

PA & VA System- Detailed Technical Specifications

1) **GENERAL**

PA- and VA-Systems feature audio processor system incorporating 10-channel technology. Any requirements and system configurations can be programmed in an extremely short time via PC processor module which saves controls and permanently monitors all functions of a system.

The PA/VA is based on internal audio and digital busses and on control hierarchy which allows for programming of over 100 priority levels. Therefore the maximum number of inputs and outputs is not limited. The system design is fully modular to meet exactly the customer requirements. Any further system expansion after the commissioning of the system is easily possible by plug-in of the required modules and quick re-programming of the system.

The entire system is microprocessor controlled and PC programmable. The programming software allows for quick configuration and system programming by "Drag & Drop". The software is also designed for easy commissioning and maintenance of the system providing comfortable software tools such as
- Simulation mode for "program dry run" on PC only (no hardware required)
- Host mode for visualisation of system functions on the system
- Hardware test mode for system diagnosis

Furthermore, the multifunctional programming software provides a documentation tool which creates automatically a hardcopy of the customer specific programming. The software can also be used for creating customised module labels for highest level of user friendliness.
The System will be manufactured by

2) **IP-media software - EN 60849:**

Application & management software responds to public address requirements and EN 60849 compliance (local) when several PAVA systems need to receive audio and be controlled trough a TCP/IP network.
The system comprises:
• A PC server (conventional PC) with the Application & management software Soft Server and the MP3 message/Music files library. It can contain thousands of MP3 files for either background music or pre-recorded messages to be broadcasted into the TCP/IP network. Up to 10 simultaneous music/message files can be broadcasted into the network.
Application & management software **add the following features to the integration**

• Audio server with MP3 message/Music files library.
It can contain thousands of MP3 files for either background music or pre-recorded messages to

be broadcasted into the TCP/IP network.
• Remote station status reporting global.
• Optional server and network redundancy.
• Visualization and recording (Log file) of events and Remote systems faults.
• TCP/IP network address administration on Application & management software IP-media software.
• Microphone calls in any zone or group of zones of any part of system.
• Broadcasting of pre-recorded messages in any zone or group of zones.
• Background music pre-recorded on server or played on external music source.
• Live recording of microphone calls to be broadcasted later on.
• Pre-recorded messages stacking. Up to 100 messages can be stacked.
• Message scheduler (time, day of the week, number of times.
• User management with up to 10 configurable and password protected profiles.
• PAVA system administration with application software.
• Recording on log file of calls, messages, and Application & management software and System faults.
• MODBUS protocol for third party control.

3) <u>Networkable PAVA system - EN54 -16 :</u>

The DSP Module (Digital Signal Processing) is for optimisation of the system performance. It is equipped with a latest generation processor which is able to provide the following functions simultaneously:

- Frequency Equalizer for quality enhancement of announcements and music
- Digital Delay for compensation of sound propagation delay
- Ambient Noise Sensing for automatic volume compensation
- Feedback Reducer for elimination of microphone feedback
- Interfaces: Standard Local Networking, 2 x RJ45. 100 m.
- Ethernet interface, TCP/IP, MODBUS, 3rd part devices.
- 4 x Security microphone connection, RJ45, PC1 to PC4 supports: MODBUS, and 3rd part devices.
- 8 balanced audio outputs + 2 audio outputs for back-up amplifiers.
- Return 100 Volt lines input from amplifiers.
- Outgoing 16 (8+8) 100 Volt lines to the loudspeakers. (AB-zoning).
- Optional 2 slots for 8 mic/line or AES/EBU audio inputs/outputs.
- 9 logic inputs and 8 logic outputs.
- Security contacts for: evacuation and fault reporting and fault-back inputs (BSI).
- 1 hour of messages storage playing up to 48 messages simultaneously
- 8 analogue audio inputs and 8 analogue audio outputs.
- The outputs have selectable 18 or 20 kHz monitoring signal for end-off-line monitoring or, using defined monitoring windows, individual monitoring with an accuracy of up to 5% of the total line load.
- 8 alarm control inputs and 8 output relays are freely programmable for system actions and priorities can be assigned to these inputs.

- 2 card slots for optional 8 microphone/ line or AES/ EBU audio input/output channels. These inputs/outputs are free software configurable.
- Compatibility with the IP-media streamers allowing for additional IP-Audio IN/EX streamer units, IP-media consoles and IP-Paging consoles.
- Net Secured Audio Network that is providing a Single or Multi-mode, 48 audio channels, 32bit, 48 kHz, redundant network.
- Up to 100 priorities that can be configured for up to 100 zones (200 AB) in the LOCAL Network.
- A system configuration that can connect up to 32 controllers with slaves (AB)'s over the LOCAL Network allowing a system configuration of up to 32 x 8 zones.
- Independent operation without a PC connected to it. The PC can be disconnected after configuring the system.
- Front panel colour touch-screen display and corresponding push buttons, that allows for simple navigation through the various system menu's.
- Automatic messaging in the Controller unit and (AB) Slave units with a capacity of up to 1 hour of WAV format audio files. The audio messages can be uploaded via Ethernet link.
- 4 audio streams that can be activated at the same time and up to 48 in the controller System.
- Message player and messages monitoring.
- Full monitoring starting at the capsule of a microphone console to the end of a loudspeaker line. The external cables connected to the control inputs are monitored for short and open circuit and earth leakage.
- Standard test, alarm and chime-tones are stored in the Controller unit and (AB) Slave units.
- An internal real time clock for automatic scheduled activities like; playback of messages, automatic volume changes during day and night or background music settings.
- Extensive audio pre and post processing possibilities for audio inputs and audio outputs.
- A monitoring loudspeaker and fireman's microphone on the Controller unit.
- Switching mode for multi-zoned amplifier usage.
- Integration of PA- and VA-Systems into a Local Area Network (LAN)
- The Systems is integrated into a Local Area Network using the interface module. This interface module converts the audio signal into a MP3 bit stream using very fast UDP protocol for transmission. Control data are sent via TCP/IP to the corresponding system. This technology allows for broadcast of the audio signal to unlimited number of subsystems simultaneously within less than 20 ms.
- Using a LAN/WAN is the easiest and most reliable method of networking PA and VA Systems. A standard network connection suffices for transmission of date and digitised audio signals even over large distances. The system can be expanded even with Fiberoptic links as required using network components.

4) <u>Digital microphone consoles with direct LAN connection</u>

- The CD-TOUCH paging console is a paging interface that allows call-paging, message broadcasting and DSP matrix parameter control. It contains a 5" full-colour backlit touch-screen for simple, user-friendly operation. The screen offers up to 150 buttons across pages which can be freely assigned in the software to any zone or group of zones. Each key contains a colour-changing field indicating if the zone is occupied by a different process. In addition, the CD-TOUCH has 3 hardware keys that can be assigned within the system control software.

- All paging parameters for site operation can be pre-programmed and stored within the console, including message triggering, level adjustment and pre-call chime setup. Zone assignment, naming and grouping can also be preconfigured.
- The CD-Touch-XX units connect to a monitored bus on CAT-5 FTP/STP. This connection also provides Power over Ethernet (POE). In case POE is not available, or if the cable run is greater than 100m, an additional power connection is provided for 24V DC.
- The range of security systems complies with current architectural demands requiring IP and/or fibre optic networking to allow for even the most complex of system designs. The system responds to Public Address and Voice Alarm requirements as stated in EN54-16, ISO 7240-16 and BS5839/8, with specific attributes for compliance in large
- Installations. CD-TOUCH is available in two different versions for compatibility with different systems. Both are identical in hardware and functionality but require different firmware.

- all-mount metal enclosure with lockable cover
- • Secured CAT-5 link to controllers and slaves
- • Monitoring of microphone capsule specifications
- • Monitoring loudspeaker
- • 5" full colour touch-screen, 800x480 pixels
- • 14 pages of 12 buttons
- • Power, Fault and Evac indicators
- • Comprehensive system status information from touch-screen
- • EN54-16 certified.

Technical Specifications

Electrical

Battery power supply
Voltage: 18 - 26 VDC
Power consumption: 250 mA

Performance

Frequency response: -3 dB @ 40 Hz and 18 kHz
THD: < 0,1% @ 1 kHz
Output level: Max -6 dBu
Noise gate threshold: -84 dBu – 24 dBu
Attack time: 8 ms
Release time: 100 ms
Output impedance: 100 Ohm

Monitoring speaker

Impedance: 4 Ohm
Output power: 1 W @ 1 KHz
Frequency response: -3 dB @ 200 to 12 kHz

System Connection
Cable type CAT-5 (FTP)
Length 100 m (max.)
Environnemental
Operating temperature: -5 ºC to +55 ºC (+23 ºF to +131 ºF)
Storage temperature: -40 ºC to +70 ºC (-40 ºF to +158 ºF)
Relative humidity: 15% to 90%
Air pressure: 600 to 1100 h Pa.

3. <u>IP Paging Console:</u>

The IP paging console is a man-machine interface which allows call-paging, messages broadcasting. Its back-lit touch screen is designed for simple and user-friendly operating. The 3 hardware keys can be freely assigned by software. The Media console is a versatile device that fits well in a commercial shopping center as for an industrial environment where paging over IP-networking brings flexibility and easy access.

All paging parameters needed for site operating can be programmed: zones assigned to the different buttons, name of zones, group of zones, messages triggering or event control. A total of 150 keys over 14 pages allow zone or group of zones selections. The prerecorded messages and the chime are stored into the IP paging console.
All the settings are done through web pages with web browser. The unit should contain echo cancellation, to deliver clear sound for full duplex talk.

22” TFT full colour paging console

• High quality gooseneck microphone
• Built in loudspeaker
• Ethernet interface including POE (Power Over Ethernet)
• 24 VDC power supply (if no POE available)
• Automatic gain control on microphone input
• Echo cancellation / noise reduction
• G.711, G.722, MP3 audio encoding /decoding
• Half or full duplex talk
• Memory space for pre-recorded messages
• POWER / FAULT / EVAC LEDs
• 3 key-buttons: User definable using ATEÏS Studio GUI
• 168 Touch fields: 14 pages with 12 keys
• RJ 9 for optional telephone headset
• 2 mini-jack plugs for optional headset
• Microphone: Length: 275 mm, Bandwidth 100 Hz -7 kHz
• Speaker: Power W rms, Bandwidth
• Weight: 1,1 kg
• Power consumption: 6 W
• Material: metal back, PVC top and sides.

<u>Table top microphone consoles:</u>

This unit should use a uni-directional addressable condenser paging microphone compatible with DSP and controller system. The unit uses RS485 protocol over a single CAT-5 cable connection to transport both audio and power from the paging console to the system units. The unit has 8 zone buttons with a sleek gooseneck microphone, providing both durability and aesthetics in a slim, stable chassis.

The unit enables live announcement to any pre-assigned zones (an optional version also allows broadcast of pre-recorded messages). The paging station has a gooseneck microphone, a push-to-talk button, zone selection keys and a monitor speaker. Buttons can represent a single zone or a group of zones and are easily defined in the software using a simple matrix selection.

All buttons can be programmed with drag & drop features from the software and each button can be programmed for PTT (Push To Talk) or latching functionality.
In addition to the zone LEDs, “Hold” and “Busy” LED signals
The uni-directional condenser microphone will ensure high-quality directive signal pick-up from the user with minimal interference from the surroundings thanks to the cardioids polar pick-up pattern. In accordance with BS5839, the unit will be is monitored on RS485.

The RS485 communication protocol allows daisy-chaining up to 300m on a single CAT-5 cable (FTP/STP) and makes each station easy to connect using standard RJ45 connectors and the junction connection box (supplied as a part of the unit).
If Power over Ethernet is not available, or the CAT-5 cable is over 50m long, the console can be powered locally with a 24 VDC supply.

Note:
The paging console firmware should have compatibility with the systems.

Features
• Desktop enclosure
• Monitored CAT-5 link to controllers and slaves
• Supervision of microphone capsule (not on slave units)
• 8-zone selection keys (Expandable with additional keypads)
• All-call key
• Power indicator
• EVAC indicator
• Status and fault indicator
• Monitor speaker

Technical Specifications - Electrical

Battery power supply
Voltage: 18 - 26 VDC
Power consumption: 120 mA
Performance
Frequency response: -3 dB @ 40 Hz and 20 kHz
THD: < 0,1% @ 1 kHz
Output level: Max 6 dBu

Noise gate threshold: -84 dBu – 24 dBu
Attack time: 8 ms
Release time: 100 ms
Output impedance: 100 Ohm
Monitoring speaker
Impedance 4 Ohm
Output power 1 W @ 1 KHz
Frequency response 3 dB @ 200 to 12 kHz
Cable
Cable type: CAT-5 (FTP)
Length: 100 m
Environnemental
Operating temperature: -5 ºC to +55 ºC (+23 ºF to +131 ºF)
Storage temperature: -40 ºC to +70 ºC (-40 ºF to +158 ºF)
Relative humidity: 15% to 90%
Air pressure: 600 to 1100 h Pa
IP-rating: 30

4. Charger and monitoring unit - EN 54-4:

The charger will be equipped with heavy duty power connectors and a main battery entry for extra safety during installation. All outputs are electronically fused (20 A).

Beside a charger for a 112 or 225 AH 24 VDC battery, the charger will also equipped with a separate 120 Watt 24 VDC power supply that acts as auxiliary output for the individual controllers mainframes in case of an internal power supply failure. In case of a mains failure, the amplifiers are forced into sleep-mode and will continue with loudspeaker line surveillance, drawing only a fractional current from the batteries.

In case of an EVAC, the amplifiers will be forced alive for duty using the battery- back-up supply. (Commercial use still disabled). This way the batteries are secured for emergency applications with a maximum availability for the amplifiers.

- 2-3U-rackmount charger
- 3 Auxiliary outputs max. 5 Amp combined load
- 2 Main outputs, max. 40 Amp combined load
- Battery capacity: 85 AH to 225 AH
- 2-3U-rack-frame charger
- 3 Auxiliary outputs max. 5 Amp combined load
- 6 Main outputs, max. 20A mp/ch
- Battery capacity: 85 AH to 225 AH

Electrical - Mains power supply
Voltage 115 or 230 VAC ±15%, 50/60 Hz
Power consumption 380 W at Full load
Battery power supply
Voltage 24 VDC

Maximum charging current
Outputs
Main for amplifiers
2 x 20 A
6 x 40 A
Auxiliary for controllers 3 maximum current 5 Amp
Batteries 4x 12 VDC, 85 to 225AH
Brands
Yuasa NPL series
Power sonic GB series
ABT TM series
Enterasys VE series
Effect BTL series
Long GB series
Mechanical
Dimensions (H x W X D)
19” rack use,
Mounting 19”-rack mount
Environmental
Operating temperature -5 ºC to +45 ºC
Storage temperature -25 ºC to +85 ºC
Relative humidity 20% to 95%
Air pressure 600 to 1100 h Pa

5. Alarm input extension unit -:

This unit is an extension unit to the controller. Each unit will provide those systems with 32 additional alarm inputs. Each input is monitored and can be programmed to trigger a digital audio message into a specific zone or group of zones. The unit is linked to the System units trough a RS232 /RS485 monitored serial link.

Desktop enclosure
- Secured RS232/RS485 link to controllers and slaves
- 32 alarm inputs
- Status and fault indicator

Technical Specifications - Electrical

Battery power supply
Voltage: 18 - 26 VDC
Power consumption: 30 mA
System
Evacuation inputs
Contact mode: 5 VDC

Voltage mode: -6 dBu
Monitoring resistor: 4K7 Ohm
Cable
Cable type: CAT-5 (FTP)
Length RS485 up to 600 m
RS232 up to 15 m
Environnemental
Operating temperature -5 ºC to +55 ºC
(+23 ºF to +131 ºF)
Storage temperature -40 ºC to +70 ºC
(-40 ºF to +158 ºF)
Relative humidity 15% to 90%
Air pressure 600 to 1100 h Pa

6. IP-media streamers:

IP-media streamers have been designed to suit simple point to point or point to multi-point audio and data gateways with no direct need for a PC. Media streaming for radio broadcasting, paging or a 2-way communication, the unit will fulfil. Each unit provides 2 audio input and 2 audio output channels using fast SPEEX encoding or high quality MP3 encoding.

Switching and indication contacts are provided for system interfacing and there is a web-server for direct configuration access. The IP-media streamers enable low cost and low power audio distribution and communication using LAN or WAN (VPN).

(SIP compatibility will be cherished as providing internet connectivity for VOIP applications).

4-1, IP-media streamer
2 balanced 0 dB to -60 dB audio inputs, 2 balanced 0 dB audio outputs, one IP-address, and 4 switching contacts
(2 in/2 out).

4-2, IP-media streamer
4 balanced 0 dB to -60 dB audio inputs, 4 balanced 0 dB audio outputs, two IP-addresses, and 4 switching contacts (2 in/2 out**).**

4-3,IP-media streamer
6 balanced 0 dB to -60 dB audio inputs, 6 balanced 0 dB audio outputs, three IP-addresses, and 4 switching contacts (2 in/2 out).

,4-4, IP-media streamer
8 balanced 0 dB to -60 dB audio inputs, 8 balanced 0dB audio outputs, four IP-addresses, and 4 switching contacts (2 in/2 out).

7. Remote maintenance via the Internet

The system should also make possible to connect the LAN to the Internet using standard network components. The System is assigned its own IP address, thus allowing status polling or system re-programming via the Internet.

8. 100% reliability with digital line monitoring

The LAN connection must be monitored digitally and thus offers 100% reliability. A ring structure of the line (redundant system) means that even line discontinuities do not lead to system failure. This means that such a system is also eminently suitable for use in evacuation systems in accordance with EN 60849/BS 5839 standard.

9. Amplifier Monitoring

The amplifier level monitoring measures permanently the output level of the amplifiers. If the level of one amplifier drops below a programmable tolerance the surveillance module switches automatically to the stand-by amplifier and the faulty amplifier is disconnected from the system. LED’s at the front of the module will indicate the faulty amplifier.

10. Loudspeaker and Line Monitoring

The loudspeaker and line monitoring is based on impedance measurement which allows for fault detection of one single loudspeaker in a line. The impedance measurement does neither require a DC-block capacitor on each loudspeaker, nor an “end of line” resistor, nor a line back from the last loudspeaker to the system nor an active electronic board at the end of the line. Regardless of the loudspeaker cable installation, it will measure the overall impedance and any deviation of the calibrated line impedance is indicated with LED’s at the front of the module. In case of a short circuit in the loudspeaker line it disconnects automatically this line from the amplifier in order to avoid amplifier damage and signal loss on other lines connected to the same amplifier.

11. Complete System Surveillance complaint EN54-16

In order to comply with the safety standard EN 54-16, the Voice Alarm System must permanently monitor the following equipment:
- Fireman’s microphone (including microphone capsule)
- Evacuation consoles and panels (including microphone capsule)
- Message and siren generators
- Amplifiers with automatic switch to stand by amplifier in case of amplifier fault
- Loudspeaker and Line (including line disconnection in case of short circuit)
- Interface to fire detection system
- Signal path inside the system which is relevant for evacuation messages
- Power supplies and battery backup

According to EN 54-16, the system must log up to 99 system faults in a non-volatile memory which is protected from unauthorised access.
Fault messages can be downloading from the system and either printed out or saved in electronic format.

12. POWER AMPLIFIER

Security Amplifiers, EN 54-16

The amplifier should have 4-channel class-D power amplifier, transformer isolated for 100 V, 70 V, 50 V and low-impedance distributed loudspeaker systems. Each amplifier can deliver up to 1000 Watt when used in bridged mode or in separate channels of 125 or 250 Watt. This will give flexibility
To design speakers lines
The amplifier will have a dual voltage mains 110/230 VAC and a 24 VDC battery back-up input which allows it to be used in combination with a battery backup system for maximum availability and durability in an emergency evacuation system. The types of power amplifiers:

150w/250w/500w Watt class-D power amplifier.

- 2U high, 19-inch rack mountable.
- Quiescent current in sleep mode: 30 mA.
- Front panel indicators include:
- General status: Power, Battery, Service and General Fault.
  Detailed status: Signal, Clip, Fault and Ready
  (Ready = out of sleep mode).
- 100 / 70 / 50 / 4 Ohm available via terminal blocks at the rear.
- Output channels can be linked into 2 x 250 W or 2 x 500 W
  by daisy-chaining 50 V tapping (input on parallel).
- Combines with the BECS150 charger and back-up supply.

At the rear

- Mains switch with fuse
- Individual level adjusters
- General fault contact (Dry contact)
- Commercial use disabled contact
- Lamp test input contact

Electrical

Mains power supply

Voltage 115 or 230 VAC ±15%, 50/60 Hz
Power consumption** standby - idle* - Pmax
DPA4250 1 W – 44 W – 1169 W
** (Total Mains-power consumption @ 230 VAC)
*(Alarm cycle + 10 V pilot-tones @ 24 VDC)

Battery power supply

Voltage 19-30 VDC

Power consumption*** standby - idle* - IMAX
DPA4250 0.03 A – 1.65 A – 43.85 A
*** (Total DC-current @ 24 VDC)
*(Alarm cycle + 10 V pilot-tones @ 24 VDC)

Line inputs 4 x (One per channel)

Connector 3-pin phoenix
Frequency response +/-3 dB @ 50 Hz and 20 kHz
S/N > 90 dB
THD < 0, 1% @ 1 kHz
Input sensitivity 770 mV
Input impedance 20 kOhm

Loudspeakers outputs

Rated load resistance 40 ohm (100 V)
Rated load capacitance 120 NF (100 V)
Rated output power
(Per channel)150w/ 250 W/500w (cont. at 40°C)

Frequency response 40 Hz to 20 kHz (-3 dB)

S/N >90 dB (no pilot tone)
Crosstalk <70 dB at nominal load for 1 kHz
Distortion <0, 1% (@ 1 kHz) @ -10dB of rated output power

Mechanical

Dimensions (H x W X D) 19" rack use, with brackets
Mounting 19"-rackmount

Environmental

Operating temperature -5 ºC to +55 ºC (+23 ºF to +131 ºF)
Storage temperature -40 ºC to +70 ºC (-40 ºF to +158 ºF)
Relative humidity 15% to 90%
Air pressure 600 to 1100 h Pa.

Equipment Racks - General

Introduction

Wherever possible, install equipment associated with the various facilities in racks based on the 483 mm panel system (19" Rack).

Supply and install as many racks as necessary to accommodate the equipment and facilities which you are installing.

Use identical racks and agree positions for the racks with the Supervision Engineer before proceeding. Below, typical details of the rack requirements are given.

Use equipment racks capable of accommodating between 9 units and 42 units of racking space as appropriate, for use with a 483 mm panel system. If the weight of equipment within the rack is likely to result in the rack being unstable, fit a plinth of an appropriate size to the front of the rack base or secure the rack to the wall by suitable means.

Ensure that all permanently installed cabling entering and leaving the rack does so either via trunking or conduit.

Before ordering the racks, agree details of the equipment and locations for the equipment within the racks with the Supervision Engineer.

Supply racks containing the facilities described in the following sections.

Side/Rear Panels & Front Door

Fit each rack with an easily removable rear panel. Where racks form the end of a row, fit easily removable side panels to each of the end racks.

Supply easily removable lockable glass doors and install them on the fronts of racks not requiring operational access. Identify the racks on which you propose to install front doors.

Rack Light Units(0ptional)

Supply a retractable light unit for use with the equipment racks. Install the unit in the rack such that it is just above the area in which the system's operational controls are located, to provide local illumination under low level lighting conditions. Ensure that operating the light switch does not result in unwanted clicks on any other systems. Also ensure that operation of the fitting does not cause interference on any of the audio circuits.

Rack Shelf & Drawer Units

Supply and install a shelf unit for mounting within the rack. Mount the shelf on runners, so it can be withdrawn and retracted as and when required. Ensure the top of the shelf is finished in a suitable resilient material. Mount the shelf at a height enabling it to be used comfortably during maintenance periods.

Supply and install a drawer unit for mounting within the rack. Mount the drawer on runners, so it can be withdrawn and retracted, as and when required. Mount the drawer at a height so it is readily accessible for storage.

If more convenient, use a combined shelf and drawer unit.

Ventilation

Install a fan unit if the rack requires more than natural ventilation. If a door is fitted to the rack, ensure its height is reduced to take account of the panel height required by the fan unit. Ensure the noise generated by the fan unit is not greater than the background noise level of the area in which the rack is installed.

Mains Isolator

Supply and fit an MCB on a panel which can be used as the rack isolator. Locate the isolator towards the bottom of the rack. Connect the MCB between the incoming mains supply and the mains distribution facility installed within the rack. Ensure the MCB has an associated illuminating indicator to show when power is present within the equipment rack.

Mains Power Distribution

Use 16 amp unswitched, IEC or any other outlets suitable for mains voltages, for power distribution within the equipment rack. Connect the distribution system so that it is controlled by the mains isolator located at the bottom of the rack.

Allow 4 no. spare socket outlets within the equipment rack for the connection of additional equipment.

Rack Power Separation

Ensure the equipment within each rack is powered from the distribution system associated with the rack, and not linked from an adjacent supply.

If for operational reasons, equipment within a rack must be powered from different sources, or where there are mains supplies from different phases within racks, ensure that this situation is clearly identified. Ensure there is warning labelling installed to clearly indicate this situation.

Position the labelling so it is clearly visible to anybody who may be working on the equipment within the racks.

Mains Power Outlet

Supply and install 2 no. twin socket outlets on the mains isolator panel. If possible, use sockets which are individually switched and are each fitted with a neon indicator. It is intended that the sockets will be used for maintenance purposes. Ensure the sockets are fed via an associated RCD. Connect the sockets and RCD so they can operate independently of the MCB associated with the rack power distribution facility.

Earthing

It is intended that the mains supply to the equipment racks will be dedicated. It may also have a technical earth associated with it. Arrange your earthing within the systems/installation so that hum resulting from earth loops is eliminated. Whatever arrangement you use must not compromise the earthing procedures necessary to comply with electrical safety requirements and regulations.

Blanking Panels

Fit blanking panels on any areas of the equipment rack not occupied by equipment. Ensure all blanking panels are the same colour.

Labelling

Clearly label each rack in terms of the system installed within it. In addition, label each panel area with a suitable description egg, (1) Audio mixer, (2) Cassette deck (3) CD player, (4) Power amplifier.

Rack Layouts

Prior to installing equipment submit layouts for all racks for comment by the Supervision Engineer.

Speakers :

Ceiling Speakers – Full Range

Size:	**6.5"-4"**
Power:	**6/3/1.5w**
Frequency Range:	**100-16.000 Hz**
SPL 1W/1m:	**97 dB**
SPL Pmax/1m	**105 dB**
Temperature range:	**-20/+80^{0}C**
Dispersion angle (-10 dB):	**180^{0} (H) / 180^{0} (V)**
Mounting:	**Quick fit mounting**
Type	**RCF –PL-60**

13. Ceiling Speakers – TWO WAY

Size:	**6.5"**
Power:	**10/6/3/1.5w**
Frequency Range:	**65-20.000 Hz**
SPL 1W/1m:	**94 dB**
SPL Pmax/1m	**104 dB**
Temperature range:	**-20/+80^{0}C**
Dispersion angle (-10 dB):	**180^{0} (H) / 180^{0} (V)**
Mounting:	**Quick fit mounting**
Type	**RCF –Pl-6x**

14. Sound Projector

Size:	**4"**
Power:	**20/10/5/2.5w**
Frequency Range:	**150-20.000 Hz**
SPL 1W/1m:	**99 dB**
SPL Pmax/1m	**110 dB**
Dimensions	**220x100 mm**
Temperature range:	**-20/+100^{0}C**
Dispersion angle (-10 dB):	**360^{0} (H) / 360^{0} (V)**
Protection Class:	**IP65+SALTWATER-RESISTANT**
Mounting:	**"u" mounting Bracket**
Type	**RCF DP4**

16. HORN Speakers

Power:	**30/20/10/5w**
Frequency Range:	**300-12.000 Hz**
SPL 1W/1m:	**110 dB**
SPL Pmax/1m	**124 dB**
Temperature range:	**-50/+100^{0}C**
Dispersion angle (-10 dB):	**140^0 (H) / 140^0 (V)**
Protection Class:	**IP 66 certified +SALTWATER RESISTANT**
Mounting:	**"u" mounting Bracket**
Type	**ATLASSOUND AP30T**

End Of Section

AUGUSTA VICTORIA HOSPITAL
CHEMOTHERAPY UNIT
RENOVATION & REHABILITATION

TENDER AND CONTRACT DOCUMENTS

MECHANICAL SPECIFICATIONS

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DIVISION 22 - PLUMBING

DIVISION23- HEATING. VENTILATING AND AIR-CONDITIONING

DIVISION24- MEDICAL GAS.VACUUM AND WAGD SYSTEMS

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SECTION 211100

FIRE SUPPRESSION PIPING

FIRE SUPPRESSION PIPING

PART1 GENERAL

Works of this Section shall be governed by Conditions of Contract and it's requirements.

1.1 GeneralRequirements

1.1.1 Pipe bending shall not beresorted toexcept inextreme cases and only after the written approval of the Engineer.
1.1.2 Piping shall be designed with Loops to take the thermal expansion. Wherever this is not possible for physical reasons, expansion joints with guides shall be used.
1.1.3 Installation of pipes shall be complete with all cutting, patching and making good of walls, slabs, partitions, etc. due to fixing, supporting and anchoring of pipes.
1.1.4 Automatic air vents shall be installed at all air pocket locations, and/or at the highest points in the lines.
1.1.5 Pipes and fittings shall both be manufactured according to one single standard unit of measurement, either both English or both metric.
1.1.6 Provision shall be made for flushing the system.
1.1.7 All piping shall be installed so that the system may be thoroughly drained.

1.1.8 The piping shall be pitched in the direction of drainage.

1.1.9 Drain valves shall be provided where necessary, where shown on the Drawings and at all sectional valves to help draining the major part of the system. On all risers4"(100mm) or larger, drain valve shall be 2"(50mm) size, on 2½" (65mm) and 3"(80mm) risers, 1¼" (32 mm) valves shall be used and on small risers, ¾" (20mm) drain valves shall be provided.

1.1.10 No direct interconnections shall be made between sewers and fire drain systems.

1.1.11 Fire piping shall not be used, in anyway, for domestic water supply purposes.

1.1.12 All valves shall be located where readily accessible.

1.1.13 Provision shall be made for test connections and valves.

1.1.14 Control power transformer as applicable to limit control voltage to24VDC maximum.

1.2 Tests

1.2.1 The system shall be subjected to a hydrostatic pressure test, to the satisfaction and in the presence of the Engineer. Pressure shall not be less than 300psi(2070 KPa)orat50psi. (345 KPa) in excess of the maximum static pressure when the maximum static pressure is in excess of 150psi(1030 KPa) and the test shall be maintained for two hours.

1.2.2 If leaks develop during the test, the contractor shall make all necessary repairs and shall retest the system at no additional cost to the Employer.

1.3 Related Work Specified Elsewhere

1.3.1 The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated here in verbatim.

Section 1044 00	-Fire Protection Specialists
Section 210516	-Expansion Fittings and Loop For Fire Suppression Piping
Section 210523	-General Duty Valves for Fire Suppression Piping
Section 210529	-Hangers and Supports for Fire Suppression Piping
Section 210548	-Mechanical Sound, Vibration, Seismic Control for Fire Suppression Piping and Equipment.
Section 210553	-Identification for Fire Suppression System
Section 211200	-Fire Suppression Stand Pipes
Section 211300	-Fire Suppression Sprinkler Systems
Section 212000	-Fire Extinguishing Systems
Section 213000	-Fire Pumps

1.4 Codes and Standards

1.4.1 Codes and standards applicable to this section shall be primarily British Standards and United States Codes, unless otherwise specified, the performance/manufacturing standards o fitems mentioned in this section shall conform to the applicable portions of the latest editions ofthefollowing codes, standards andregulations.

	Reference Code	Abbreviation	Applicable Standard	Title of Standard
1.	Underwriters UL Laboratories	UL	-	-
2.	British Standards	BS	BS3169	Specification for first aid reel hoses for fire fighting purposes
			BS5839 Part 1	Fire detection and alarm systems for buildings code of practice for system design installation and servicing
3.	National Manufacturers Association	NEMA	MIG Part 14	-
4.	National Electrical Code	NEC	-	-
5.	National Fire Protection Association	NFPA	14	Combined Stand Pipe and Hose System with Sprinklers
6.	American Water Works Association	AWWA	-	-
7.	Loss Prevention Council	LPC	-	THE LPC rules for automatic sprinkler installations

PART 2 PRODUCTS

2.1 Fire Suppression Pipe

2.1.1 Pipes a bove ground shall be of the ERW type galvanized steel pipes to B.S. 1387 "medium weight" or ASTM A 53-88a Sch. 40. All pipe fittings elbows, tees, crosses, unions, reducers, etc. shall be of the same quality and weight as the pipes.

2.1.2 Pipe fittings 2"(50 mm) and smaller shall be suitable for threaded connections, *2W' (65*mm) and larger shall be flanged **/** grooved fittings.

2.1.3 Unions and grooved fittings, flanges shall be installed at all valves inlets or outlets, on all pipe branches and in general, every 15meters of piperun.

2.1.4 Unions shall be used on all screwed pipes and shall be of the same quality and service. Grooved fittings shall be used on all pipes above 2%"and shall be all steel construction to ASTM or BSS tandards.

2.1.5 Contractor shall rectify any damage to the pipes from the processes of grooving to the satisfaction of the Engineer.

2.1.6 Pipes underground shall be HOPE to ISO 4427, PE 100 resin all fittings shall be electro fusion and butt fusion types.

PART 3 EXECUTION

3.1 Pipe Installation

3.1.1 Piping shall be pitched to permit complete draining of the system.

3.1.2 Fire stand pipe shall not be used in any way to provide water for other purposes.

3.1.3 Provide all pipe openings through walls, partitions and slabs with sleeves having an internal diameter at least 50mm larger than the outside diameter of the pipe for un- insulated lines or of the insulation for insulated pipes.

3.1.4 Install sleeves through interior walls and partitions flush with finished surfaces; sleeves through outside walls toproject 15mm. on each side of the finished wall; and floor sleeves to project 25mm. above finished floors.

3.1.5 Set sleeves in place before pouring concrete or securely fasten and grout in with cement.

3.2 Cleaning of Piping Systems

3.2.1 Plug all opening ends of piping, valves and equipment except when actual work is being performed to minimize accumulation of dirt and debris.

3.2.2 Prior to the performance of tests, flush out all piping that is to receive any drostatic test with clean water.

3.2.3 Remove dirt and debris collected at screens, strainers and other points from the system.

3.3 Approved List of Manufacturers

3.3.1 For acceptable Products, Manufacturers and Suppliers, refer to Appendix A.

End Section 211100

SECTION 21 12 26

FIRE SUPPRESSION VALVE AND HOSE CABINET

3.3 Approved List of Manufacturers

FIRE SUPPRESSION VALVE AND HOSE CABINET

PART 1 GENERAL

1.1 **General Requirements**

1.1.1 To be read and governed by general Conditions of Contract and its Sections.

1.1.2 The Contractor shall be responsible to confirm and seek the approval of the fire department or persons having jurisdiction and the approval of the Engineer before ordering the materials.

1.1.3 Pipe bending shall not be resorted to except in extreme cases and only after the written approval of the Engineer.

1.1.4 Automatic air vents shall be installed at all air pocket locations, and/or at the highest points in the lines.

1.1.5 Pipes and fittings shall both be manufactured according to one single standard unit of measurement, either both English or both metric.

1.1.6 Provision shall be made for flushing the system.

1.1.7 Drain valves shall be provided where necessary, where shown on the Drawings and at all sectional valves to help draining the major part of the system. On all risers 4" (100mm) or larger, drain valve shall be 2" (50 mm) size, on 2½" (65 mm) and 3" (80mm) risers, 1¼" (32 mm) valves shall be used and on small risers, ¾" (20mm) drain valves shall be provided.

1.1.8 Fire fighting piping shall not be used, in any way, for domestic water supply purposes.

1.1.9 All valves controlling the water supply shall be located where readily accessible.

1.2 **Related Work Specified Elsewhere**

1.2.1 The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated herein verbatim.

Section 10 44 00 - Fire Protection Specialists
Section 21 05 16 - Expansion Fittings and Loop For Fire Suppression Piping
Section 21 05 23 - General Duty Valves for Fire Suppression Piping
Section 21 0529 - Hangers and Supports for Fire Suppression Piping
Section 21 0548 - Mechanical Sound, Vibration, Seismic Control for Fire Suppression Piping and Equipment.
Section 21 05 53 - Identification for Fire Suppression System
Section 21 11 00 - Fire Suppression Piping
Section 21 12 00 - Fire Suppression Stand Pipes
Section 21 13 00 - Fire Suppression Sprinkler Systems
Section 21 2000 - Fire Extinguishing Systems
Section 21 30 00 - Fire Pumps
Section 21 4000 - Fire Suppression Water Storage

1.3 Codes and Standards

1.3.1 Codes and standards applicable to this section shall be primarily British Standards and United States Codes, unless otherwise specified, the performance/manufacturing standards of items mentioned in this section shall conform to the applicable portions of the latest editions of the following codes, standards and regulations.

	Reference Code	Abbreviation	Applicable Standard	Title of Standard
1.	Underwriters UL Laboratories	UL	-	-
2.	British Standards	BS	BS3169	Specification for first aid reel hoses for firefighting purposes
			BS5423	Specification for portable fire extinguishers.
			BS5839 Part 1	Fire detection and alarm systems for buildings Code of practice for system design installation and servicing
3.	National Manufacturers Association	NEMA	MIG Part 14	-
4.	National Electrical Code	NEC	-	-
5.	National Fire Protection Association	NFPA	14	Combined Stand Pipe and Hose System with Sprinklers
6.	American Water Works Association	AWWA	-	-
7.	Loss Prevention Council	LPC	-	THE LPC rules for automatic sprinkler installations

Par t 2 PRODUCTS

2.1 Fire Hose Cabinet

2.1.1 Cabinets are as detailed on Architectural drawings.

2.2 Fire Hose Cabinet (Exposed Cabinet Type)

2.2.1 Supply and install Fire Hose Cabinets wherever shown on drawings and to the details indicated on the drawings.

2.2.2 Cabinet shall be constructed of steel 16 - Gauge for "Trim, 18 - Gauge for "Tub" and 20- Gauge for "Door". Cabinet size shall be in accordance with the details shown on drawings. Cabinet door shall be flush, pull handle and tension latches and shall be equipped with full length plan hinges on the right or the left as conditions requires.

2.2.3 Cabinets shall receive an approved shop coat of paint inside and outside.

2.3 **Hose Cabinet Equipment and Accessories**

2.3.1 Each Fire Hose Cabinet shall include the following:-

2.3.1.1 Fire hose diameter 1" (25 mm), 100ft.(30 m.) long, light weight made of red rubber with a working pressure of 150 psi. (1030 Kpa).

2.3.1.2 Hose shall comply with BS 3169 Type A.

2.3.1.3 Hose reel of the swinging type, up-to 180 degrees full swing complete with guide arm. Chromium

plated diameter 1" (25 mm) fog nozzle capable of complete shut off, straight
2.3.1.4 stream or any degree of solid conical fog.

2.3.1.5 Diameter 1" (25 mm) pressure reducing valve and gate valve with die cast non-ferrous alloy housing with machined water way.

2.3.1.6 Fire hose: 2 ½" (65 mm) dia. 100 ft. (30 m) long, light weight made of single jacket cotton rubber lined and shall carry UL Listing, with polished chrome plated brass couplings.
2.3.1.7 Hose shall be in the cabinet with no permanent connection at the riser.

2.3.1.8 Hose rack of the swinging type up-to 180 deg. Full swing complete with guide arm. Rack shall be steel backed red enamel.

2.3.1.9 Chrome - plated. All purpose nozzle 2 ½" (65 mm) dia. with adjustable spray head and capable of complete shut-off, straight steam or any degree of solid conical fog.

2.3.1.10 2 ½" (65 mm) dia. bronze angle hose landing valve with quick press-type compiling adaptor cap and chain.

2.3.1.11 6 kgs. Dry chemical fire extinguisher with spray hose and nozzle.

2.3.1.12 5 kgs. C02 fire extinguishers with spray hose and nozzle.

2.4 Fire Hose Landing Valve

2.4.1 Fire hose landing valve shall be in accordance with B.S. The valves shall be angle type, 300 psi (2070 KPa) with built-in pressure reducing and globe valve with polished, chrome-plated brass body and trim, red cast iron wheel handle, bronze stem, renewable composition disc, FLANGED 2 %" (65 mm) inlet and quick coupling outlet with polished brass chrome plated cap and chain.

2.4.2 For valves with integral pressure reducing valve, the pressure regulator shall be spring loaded with springs made of zinc plated steel and chamber of chrome plated bronze. The regulator shall have stainless steel adjusting and lock screw and ball, bronze piston and Nitride rubber low pressure seal.

Part 3 EXECUTION

3.1 Pipe Installation

3.1.1 Piping shall be pitched to permit complete draining of the system.

3.1.2 Fire standpipe shall not be used in any way to provide water for other purposes.

3.1.3 Provide all pipe openings through walls, partitions and slabs with sleeves having an internal diameter at least 50mm larger than the outside diameter of the pipe for un-insulated lines or of the insulation for insulated pipes.

3.1.4 Install sleeves through interior walls and partitions flush with finished surfaces; sleeves through outside walls to project 15mm. on each side of the finished wall; and floor sleeves to project 25mm. above finished floors.

3.1.5 Set sleeves in place before pouring concrete or securely fasten and grout in with cement.

3.2 Cleaning of Piping Systems

3.2.1 Plug all opening ends of piping, valves and equipment except when actual work is being performed to minimize accumulation of dirt and debris.

3.2.2 Prior to the performance of tests, flush out all piping that is to receive a hydrostatic test with clean water.

3.2.3 Remove dirt and debris collected at screens, strainers and other points from the system.

3.3 Approved List of Manufacturers

3.3.1 For acceptable Products, Manufacturers and Suppliers, refer to Appendix A.

End Section 21 12 26

SECTION 211313

WET PIPE SPRINKLER SYSTEM

SECTION 211313

WET PIPE SPRINKLER SYSTEM

SECTION 211313
WET PIPESPRINKLER SYSTEM

PART1 GENERAL

Works of this Section shall be governed by Conditions of Contract and it's requirements.

1.1 General Requirements

1.1.1 Pipe bending shall not be resorted to except in extreme cases and only after the written approval of the Engineer.

1.1.2 Piping shall be designed with Loops to take the thermal expansion. Wherever this is not possible for physical reasons, expansion joints with guides shall be used.

1.1.3 Installation of pipes shall be complete with all cutting, patching and making good of walls, slabs, partitions, etc., due to fixing, supporting and anchoring of pipes.

1.1.4 Automatic air vents shall be installed at all air pocket locations, and/or at the highest points inthelines.

1.1.5 Pipes and fittings shall both be manufactured according to one single standard unit of measurement, either both English or both metric.

1.1.6 Sprinkler installations shall comply fully with the requirements ofNFPA section 13and/or the rules of the loss prevention council /BS5306 Part 2 latest edition.

1.1.7 Provision shall be made for flushing the system.

1.1.8 All piping shall be installed so that the system may be thoroughly drained.

1.1.9 The piping shall be pitched in the direction of drainage.

1.1.10 Drain valves shall be provided where necessary, where shown on the Drawings and at all sectional valves to help draining the major part of the system. On all risers 4"(100mm) or larger, drain valve shall be2"(50mm) size,on2½' (65 mm) and 3" (80mm) risers, 1¼" (32 mm) valves shall be used and on small risers, ¾" (20mm) drain valves shall be provided.

1.1.11 No direct interconnections shall be made between sewers and sprinkler drain systems.

1.1.12 Sprinkler piping shall not be used, in any way, for domestic water supply purposes.

1.1.13 All valves controlling the water supply shall be located where readily accessible.

1.1.14 Provision shall be made for test connections and valves.

1.1.15 Control power transformer as applicable to limit control voltage to 24VDC maximum.

1.1.16 Protection areas and maximum spacing (Standard spray upright / pendant sprinkler) for light hazard is18 square meter and for Ordinary hazard is12.0 square meter as per NFPA13 and this shall be subject to authorities having jurisdiction

1.1.17 Protection areas and maximum spacing (Side Wall Sprinklers) for light hazard is 18.2 square meter, 9.29 square meter for Ordinary hazard and for external coverage light hazard is as per NFPA 13 Table 8.8.2.1.2 and Local Authorities having jurisdiction.

1.2 Tests

1.2.1 The system shall be subjected to any prostatic pressure test, to the satisfaction and in the presence of the Engineer. Pressure shall not be less than 300psi(2070 KPa)orat50psi. (345 KPa) in excess of the maximum static pressure when the maximum static pressure is in excess of150psi(1030 KPa) and the test shall be maintained for two hours.

1.2.2 If leaks develop during the test, the contractor shall make all necessary repairs and shall retest the system at no additional cost to the Employer.

1.3 Signs

1.3.1 Provide at sprinkler test valve a metal sign 100x200 mm size with white letters on red back ground, reading "SPRINKLER TEST VALVE". Letters shall not be less than 50mm in height.

1.4 Related Work Specified Elsewhere

1.4.1 The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated here in verbatim.

Section 104400 -Fire Protection Specialists
Section 210516 -Expansion Fittings and Loop For Fire Suppression Piping
Section 210523 -General Duty Valves for Fire Suppression Piping
Section 210529 -Hangers and Supports for Fire Suppression Piping
Section 210548 -Mechanical Sound, Vibration, Seismic Control for Fire Suppression Piping and Equipment.
Section 210553 -Identification for Fire Suppression System
Section 211200 -Fire Suppression Stand Pipes
Section 21 1300 -Fire Suppression Sprinkler Systems
Section 212000 -Fire Extinguishing Systems
Section 213000 -Fire Pumps
Section 214000 -Fire Suppression Water Storage

1.5 Codes and Standards

1.5.1 Codes and standards applicable to this section shall be primarily British Standards and United States Codes, unless otherwise specified, the performance/manufacturing standards of items mentioned in this section shall conform to the applicable portions of the latest editions of the following codes, standards and regulations.

	Reference Code	**Abbreviation**	**Applicable Standard**	**Title of Standard**
1.	Underwriters UL Laboratories	UL	-	-
2.	British Standards	BS	BS3169	Specification for first aid reel hoses for firefighting purposes
			BS5423	Specification for portable fire extinguishers.
			BS5839 Part 1	Fire detection and alarm systems for buildings Code of practice for system design installation and servicing
3.	National Manufacturers Association	NEMA	MIG Part 14	-
4.	National Electrical Code	NEC	-	-
5.	National Fire Protection Association	NFPA	14	Combined Stand Pipe and Hose System with Sprinklers
6.	American Water Works Association	AWWA	-	-
7.	Loss Prevention Council	LPC	-	THE LPC rules for automatic sprinkler installations

PART 2 PRODUCTS

2.1 Fire Suppression Pipe

2.1.1 Pipes above ground shall be of the ERW type galvanized steel pipes to B.S. 1387 "medium weight" or ASTM A 53-88a Sch. 40. All pipe fittings elbows, tees, crosses, unions, reducers, etc.shall beofthesame quality andweight asthepipes.

2.1.2 Pipe fittings 2" (50 mm) and smaller shall be suitable for threaded connections, 2½" (65 mm) and larger shall be flanged / grooved fittings.

2.1.3 Unions and grooved fittings, flanges shall be installed at all valves inlets or outlets, on all pipe branches and in general, every 15meters of pipe run.

2.1.4 Unions shall be used on all screwed pipes and shall be of the same quality and service. Grooved fittings shall be used on all pipes above 2¼' and shall be all steel construction to ASTM or BSS tandards.

2.1.5 Contractor shall rectify any damage to the pipes from the processes of grooving to the satisfaction of the Engineer.

2.1.6 Pipes underground shall be HOPE to ISO 4427, PE 100 resin all fittings shall be electro fusion and butt fusion types.

2.2 Sprinkler Head-Upright

2.2.1 Sprinkler heads shall be bronze or brass construction, spray type 1350 F(570 C) rating, with thermo sensitive glass bulb. Head located in finished areas shall be chrome-plated.

2.2.2 Not less than 12 spare sprinkler heads shall be provided together with sprinkler head wrenches, all supported on steel clip in a suitable steel cabinet with hinged door and latch. Cabinets shall be finished in red enamel with white letters on door reading: "SPARE SPRINKLER PARTS". Cabinets shall be wall hung and incompliance with all authorities having jurisdiction. Location of cabinet shall be as directed by the Engineer.

2.2.3 All sprinklers shall have a normal orifice 15mm and rated for ordinary hazard.

2.2.4 Sprinklers shall be rated for a working pressure of175PSI(1207 Kpa).

2.2.5 This type of sprinklers shall be installed in car parking and areas where false ceiling is not provided.

2.3 Concealed Automatic Sprinkler

2.3.1 The sprinkler head shall be of the quick response concealed type of brass string a3mm. diameter glass bull of 135o Frating. The sprinkler frame shall have drop-down deflector. The assembly shall be recessed in to the ceiling and concealed by a flat cover plate.

2.3.2 This type of sprinkler shall be installed in all floors.

2.3.3 Spare sprinkler heads with wrenches and cabinets to be provided as described above.

2.4 Recessed Extended Coverage Horizontal Sidewall Sprinkler

2.4.1 The sprinkler head shall be of the quick response horizontal side wall chrome plated recessed type with deflector and 3mm frangible glass bulb. The glass bulb of the fast thermal response shall consist of a controlled amount of special fluid hermetically sealed inside aprecisely manufactured glass capsule.

2.4.2 Spare sprinkler heads with wrenches and cabinets to be provided as described above.

2.5 Side Wall Sprinkler

2.5.1 The sprinkler head shall be of the quick response horizontal side wall chrome plated type with deflector and 3mm frangible glass bulb.

2.5.2 The glass bulb of fast thermal response shall consist of controlled amount of special fluid hermetically sealed inside aprecisely manufactured glass capsule.

2.5.3 Spare sprinkler heads with wrenches and cabinets to be provided as described above.

2.6 Sprinkler Heads-Pendant (Recessed)

2.6.1 Sprinkler head shall be bronze or brass construction, spray type 135°F (57°G) rating with thermo sensitive glass bulb with maximum 3" (76 mm) diameter chromium-plated escutcheon, adjustable for a minimum of W'(13 mm) for ceiling variations. Sprinklers shall be chromium-plated with maximum projection of W'(13mm) below ceiling.

2.6.2 Not less than 12 spare sprinkler heads shall be provided together with sprinkler head wrenches, all supported on steel clip in a suitable cabinet with hinged door and latch. Cabinets shall be finished in red enamel with white letters on door reading. "SPARE SPRINKLER PARTS". Cabinets shall be wall hung and incompliance with all authorities having, jurisdiction. Location of cabinet shall be as directed by the Engineer.

2.6.3 All sprinklers shall have a normal orifice 15mm and rated for ordinary hazard.

2.6.4 Sprinklers shall berated for a working pressure of 175PSI(1207 Kpa) or250 PSI (1724Kpa)for high rise buildings.

2.7 Sprinkler Alarm Test Station

2.7.1 Sprinkler alarm check valve with trim

2.7.1.1 This valve is a part of sprinkler alarm test station and servers a dual purpose of preventing reverse flow of water (non-return) and provides a hydraulic fire alarm independent of electric power supply.

2.7.1.2 Valve shall be UL listed and FM approved for a working pressure of175PSI(1207 Kpa). Valve shall have a ductile /cast iron body with internal pins, sprinkler and nuts of stainless steel and brass seat. The valve clipper shall be of Teflon coated steel with EPDM rubber clapper having stainless steel rubber faced retainer. The clapper assembly shall be hinged to access cover for quick removal and easy servicing. Valve shall be available in flanges, grooved or combined connection versions. Valve shall have necessary tapping for pressure gauges, alarm devices, drains, etc., Valve shall be suitable for horizontal or vertical installation.

2.7.1.3 The alarm valve shall be complete with external by-pass trim to minimize clapper movement and prevent false alarm. Trim shall include drain and test valve, retard chamber for variable pressure systems, pressure gauges at inlet/outlet, strainer, electric pressure switch, restricted drain orifice, water motor alarm andalarm motor stopvalve.

2.7.1.4 When water flows through the Alarm valve, the water will raise the clack disk, and flows to the system with a small amount passing thru a special groove to the alarm motor and gong and initiating the alarm.

2.7.1.5 The clack will remain in the raised position until there is no flow of water thru the control valve then the stop valve will be closed.

2.7.1.6 When sprinklers are in operation during a fire, the alarm gong may be shut off by closing alarm motor stop valve.

2.7.1.7 An electrical pressure switch connected in the flow of the alarm gong shall also initiate an electric alarm in the main fire control panel.

2.7.1.8 The drain and test valve is to drain the sprinkler installation of water after a fire has been extinguished and be for replacing the sprinklers that have operated. It is also used to test the running pressure of the water supplies.

2.7.2 Water motor alarm and gong

2.7.2.1 Water motor alarm and gong shall comprise a weather proof, hydraulically driven mechanical bell that automatically sounds a continuous alarm when the sprinkler system activates. It shall be installed not higher than 5 or 6 meters above the valve and it shall be tested at least once a week.

2.7.3 Isolating Valves (OS&YResilient Wedge GateValves)

2.7.3.1 The valve shall be provided upstream and downst ream of sprinkler control station and shall be located in such a place to be always readily visible and accessible to authorized persons. Valves shall be secured open by a padlocked or riveted strap.

2.7.3.2 The valve shall confirm to the latest revision of AW.W.A Resilient Seated Gate ValveStandard C-509 and be UL listed}FM approved.

2.7.3.3 All internal parts shall be accessible without removing the body from the line.

2.7.3.4 The wedge shall be cast iron, complete encapsulated with resilient material. The resilient sealing material shall be permanently bonded to the cast iron wedge with a rubber tearing bond to meet ASTM 0429.

2.7.3.5 NRS stems shall be cast bronze with integral collars incompliance with AW.W.A. OS&Y stems shall be bronze. The NRS stuffing box shall have two O-Ring seals above the thrust collar. These rings shall be filed replaced without removing the valve from service.

2.7.3.6 There shall be low friction thrust bearings above and below the steam collar. The stem nut shall be independent of the wedge and of solid bronze. The water way in the seat areas shall be smooth, un obstructed, free of cavities and for valves 4"(100mm) and larger at least 0.19" (4.8mm) greater in diameter than the nominal valve size.

2.7.3.7 The body and bonnet shall be coated both interior and exterior with a fusion bonded heat cured thermo setting material meeting all the application and performance requirements of AW.W.A. C-550.

2.7.3.8 The gasket seal between two surfaces shall employ the use of composition ring type gaskets retained to prevent the possibility of blow out.

2.7.3.9 Each valve shall be hydrostatically tested to the requirements of both AW.W.A. and UL/FM.

2.8 Sprinkler Zone Control Valve

2.8.1 <u>Butterfly Valve (indicating type)</u>

2.8.1.1 Butterfly valve shall be of the flangeless type, lug or wafer style, it shall be rated 1380 KPa bi-directional, witha1380 KP a dead end service rating. The body material shall be shock resistant ductile iron with extended neck. There should be no exposed fasteners in the water way to pint hedisc to the stem. The liner shall be molded in orcaptive boot design. Top and bottom stem bushings of dissimilar material are required with a positive retention mechanism for the stem.

2.8.1.2 Butterfly valve shall be gear operated and shall be secured open with a pad lock. It shall be provided with supervisory tamper switch to give signal to BMS (if specified) and to the fire alarm station.

2.8.2 <u>Water flow Alarm Switch</u>

2.8.2.1 The water flow alarm devices consist of a vane type water flow switch for use on wet sprinkler systems, it shall be UL listed and FM approved. The unit shall contain two single pole, double throw, snap action switches and adjustable, instantly recycling pneumatic retard that delays actuation of electrical switches to reduce possibility of false alarms.

2.8.2.2 The unit shall be enclosed in a die-cast housing, the cover shall beheld in place with two tamper resistant screws.

2.8.2.3 Unit shall be installed on sprinkler branch line to detect water flow exceeding 38 Litres downstream of the device. When activated, the snapaction switches shall operate a local electrical alarm bell (under electrical specification) and indicate signal to fire alarm panel and BMS.

2.8.3 <u>Combined Drain and Test Valve</u>

2.8.3.1 Drain and test valve shall have a body of brass, bronze filled Teflon seal, stainless steel stem, and zinc plated steel handle, it shall include an orifice plate signed for a flow of one sprinkler and a sight glass. Test and drain valve shall be tested once a week and it shall be connected to a separate drain riser.

2.9 Pre-Action Riser Assembly and Related Accessories

2.9.1 <u>General Description</u>

2.9.1.1 When one electrical thermal detector senses the presence offire, the electrical releasing control panel activates fire alarm devices and latches the solenoid releasing valve in the open position. The solenoid valve, when closed, is preserving supply water pressure in the inlet of the Deluge Riser Assembly. Actuating the solenoid valve releases that water pressure, allowing water flow into the sprinkler system in readiness for the subsequent operation of a sprinkler.

2.9.1.2 To fully operate the system, two electrical detectors shall activate and a sprinkler shall open. During the early stages of a fire, smoke or heat activates the first detector which causes the control panel to produce a local alarm and an alarm at the main fire alarm panel. Electrical relays inside the releasing control panel can be used to shut down air moving equipment when the panel goes into the "first alarm" condition. Subsequent activation of a second, nearby or adjacent, detector shall cause the panel to energize the solenoid valve open and release water into the sprinkler piping. Water flowing into the sprinkler piping will simultaneously produce water pressure that causes the transfer of contacts in the pressure switch mounted in the Riser Assembly. The flow of water into the sprinkler piping effectively converts the dry system into a wet pipe system. In the event the fire subsequently produces sufficient heat to operate a sprinkler head, water will flow from that sprinkler, controlling or suppressing the fire.

2.9.1.3 The solenoid valve is a supervisory valve and its circuit is supervised.

2.9.1.4 Pre-action riser assembly shall consist of the following:

- Manual Emergency Releasing Station Valve
- Supervised Isolating Valve
- Solenoid Valve
- Water Flow Alarm Pressure Switch
- Alarm Test Valve
- Automatic Drain Valve

2.9.1.5 The system shall be complete with the following:

- Control Panel
- Electric Emergency Station
- Fire Alarm Bell &Trouble Alarm Bell

2.9.1.6 Open Sprinklers (Spray Nozzle)

2.9.1.6.1 Sprinkler head shall be bronze or brass construction chrome plated pendant recessed type with chrome escutcheon.

2.9.1.6.2 Sprinklers shall be of non-automatic fixed pattern and solid cone discharge type.

PART3 EXECUTION

3.1 Pipe Sleeves

3.1.1 Piping shall be pitched to permit complete draining of the system.

3.1.2 Fire stand pipe shall not be used in any way to provide water for other purposes.

3.1.3 Provide all pipe openings through walls, partitions and slabs with sleeves having an internal diameter at least 50mm larger than the outside diameter of the pipe for un- insulated lines or of the insulation for insulated pipes.

3.1.4 Install sleeves through interior walls and partitions flush with finished surfaces; sleeves through outside walls toproject 15mm. on each side of the finished wall; and floor sleeves to project 25mm. above finished floors.

3.1.5 Set sleeves in place before pouring concrete or securely fasten and grout in with cement.

3.2 Cleaning of Piping Systems

3.2.1 Plug all opening ends of piping, valves and equipment except when actual work is being performed to minimize accumulation of dirt and debris.

3.2.2 Prior to the performance of tests, flush out all piping that is to receive a hydrostatic test with clean water.

3.2.3 Remove dirt and debris collected at screens, strainers and other points from the system.

3.3 Approved List of Manufacturers

3.3.1 For acceptable Products, Manufacturers and Suppliers, refer to Appendix

A. **End Section 211313.**

SECTION 22 05 00

GENERAL MECHANICAL REQUIREMENTS FOR PLUMBING

PART 1 GENERAL

PART 2 PRODUCTS

(NOT USED)

PART 3 EXECUTION

SECTION 22 05 00

GENERAL MECHANICAL REQUIREMENTS FOR PLUMBING

PART 1 GENERAL

1.1 General Requirements

1.1.1 The work of Division 22 shall be governed by general conditions of contract and sections of Division -22.

1.1.2 It is the Contractors responsibility to be fully aware of and comply with all of the requirements of the above documents, and further assure that all Subcontractors are equally informed.

1.2 Application

1.2.1 This section applies to and is part of all Sections of Division 22.

1.3 Scope of Works

1.3.1 The works covered under this contract include the supply, installation, testing, adjusting and putting into operation systems, components of systems, and individual items of equipment, and work related thereto, in accordance with the project Tender Documents. Products not mentioned but obviously necessary for the completion of those Works shall be provided.

1.3.2 Unless specifically mentioned otherwise, the following electrical works and materials for the Mechanical equipment shall be supplied and installed under Division 22 of the specification but in all respect to the requirements of the Electrical Specifications.

1.3.2.1 All control panels including doorlock disconnected switches, push buttons, starters, contractors, circuit breakers, time delays, selector switches, relays, transformers, timers, controllers, pilot lights, setpoints, alarms and all other electrical equipment which are necessary for the satisfactory operation, control and protection of all plant supplied under this section of the specifications.

1.3.2.2 Whenever a number of starters controllers, instruments, indicating lights and the like occur or are shown on the Mechanical and/or electrical Drawings, they shall be arranged in a central position in a neat, easily cleaned, factory-built panel, or motor control center assembly. The assembly shall include isolators and all necessary fuses, busbars, starters, instruments, relays, push-buttons, indicating lights and the like. Components shall be mounted in a logical order based on the sequence of operation.

1.3.2.3 All control equipment including sensors, detectors, actuators, controllers, pressure level and flow switches, annunciation alarms, remote control stations and all such equipment needed for the proper system operation.

1.3.2.4 All control wiring for the above mentioned equipment.

1.3.2.5 Final connection, between disconnect switches, power outlets, flex outlet and mechanical equipment.

1.3.2.6 Power cables between submersible pumps and control panel.

1.3.3 The following electrical works and materials for the mechanical equipment shall be supplied and installed under the electrical part of this contract.

1.3.3.1 All power supply up to and including the following:

1.3.3.2 Disconnect switches when specified to be installed separate from the control panel. Flex outlet for electric water heater.

1.3.3.3 Power supply upto control panels when specified with an integral disconnect switch.

1.3.3.4 Power supply to disconnect switches when the switches are built-in the equipment.

1.3.3.5 Empty conduits with pull wires for all cables and wires classified under the mechanical scope of works.

1.3.3.6 Control outlet boxes for all control equipment classified under the mechanical scope of works.

1.3.3.7 Power cables and conduits or fixing arrangement between water pumps, and their control panel.

1.4 Quality Assurance

1.4.1 The manufacturer's of all materials and equipment must have at least ten years of experience in the design and manufacture of their products.

1.5 Related Work Specified Elsewhere

1.5.1 In addition to the sections mentioned above, and unless specifically called in the specification the following works shall be referred with the other related divisions.

1.6 Engineer's Drawings

1.6.1 The Drawings are based on design and include general layouts and typical details of various systems to be installed. The Contractor shall make the installations in a workmanlike manner to conform to the structure, to avoid obstructions, to preserve head room, and to keep openings and passage ways clear without additional instruction and without additional cost to the owner.

1.7 Shop Drawings and Data to be Submitted for Approval

1.7.1 The Contractor shall submit Shop Drawings showing the exact routing and locations of all the piping, equipment, etc., all in their respective locations and according to the dimensions of the approved manufacturer. Shop Drawings scale shall be *1/10, 1/20, 1/50* and *1/100* as applicable and as approved by the Engineer.

1.7.2 The Contractor shall submit catalog cuts and brochures of products with reference to proper paragraph in specifications. All submittals shall be binded in one Booklet.

1.7.3 The Contractor shall submit adequate Engineering data on each piece of equipment together with all characteristic curves, capacity selection charts and all data for testing and

1.7.4 balancing of the systems. In addition the Contractor shall submit manufacturer's printed installation instructions.

1.7.5 The Contractor shall submit at the beginning of the project a schedule of submittals for materials and shop drawings to the approval of the Engineer.

1.8 Approved Materials

1.8.1 All materials shall be furnished in accordance with the requirements of the Specifications. The naming of manufacturers in the Specifications shall be strictly adhered to in all circumstances.

1.8.2 Substitution of materials other than those named shall not be submitted.

1.8.3 Materials shall be delivered in unbroken packages bearing the brand and maker's name, and shall be stored on platforms and properly covered to protect them from moisture, heat and dust.

1.8.4 All materials shall be supplied from the main factories in the country of origin of the manufacturer. Any deviation from this, like supplying equipment assembled in another different country under a license or another name is not accepted unless approved by the Engineer.

1.9 Instruction Period

1.9.1 The Contractor shall be responsible for the training and familiarization of the Employer's Maintenance Staff for a period of at least six weeks on all equipment and plants he has supplied or installed.

1.10 Manual and As-built Drawings

1.10.1 The Contractor shall furnish and submit to the Engineer in electronic and hard copy triplicate bound, A4 size, Instruction Manuals containing the following material.

1.10.2 Brief description of each system and its service and basic operation features.

1.10.3 Manufacturer's mechanical equipment parts list of all functional components of the systems listed on the Drawings, control diagrams and wiring diagrams of controllers. List shall give system No., unit no., Manufacturer's Model No., and Manufacture's Drawing no. Parts list shall include manufacturer's recommended spare parts for one year operation.

1.10.4 Chart of the tag numbers, location and function of each valve.

1.10.5 Maintenance instructions for each type of equipment.

1.10.6 Possible breakdowns and repairs for each type of equipment.

1.10.7 List of nearest local suppliers for all equipment.

1.10.8 Manufacturer's literature describing each piece of equipment control diagrams and wiring diagrams of controllers.

1.10.9 Complete, as installed, color coded wiring diagrams of all electrical motor controller connections and interlock connections of other mechanical equipment.

1.10.10 The Contractor shall furnish all the foregoing to the Engineer for his review as to the fulfillment of the specified requirements.

1.10.11 All items shall be available at least four weeks prior to the substantial completion date.

1.11 Abbreviations

1.11.1 The following abbreviations have been mentioned in the specifications.

AGA	American Gas Association.
ANSI	American National Standard Institute.
ASA	Acoustical Society of America, American Standards Association
ASME	American Society of Mechanical Engineers.
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association.
BSI	British Standards Institution
NPC	National Plumbing Code

UPC	Uniform Plumbing Code
UL	Under Writers Laboratories

1.12 Workmanship

1.12.1 All workmanship required to accomplish the work mentioned in Mechanical specification or shown on related Drawings, shall conform to the highest standards, and as required by the Engineer.

1.12.2 The Engineer will be the sole judge of the standards required.

PART 2 PRODUCTS

(NOT USED)

PART 3 EXECUTION

3.1 Cleaning and Adjusting

3.1.1 All apparatus shall be thoroughly cleaned before being placed in operation. Finished surfaces shall be restored if damaged and entire installation shall be delivered in perfect condition, subject to the approval of the Engineer. Systems shall be adjusted and balanced to operate as shown in the Drawings and herein specified.

3.2 Tests

3.2.1 All piping and equipment shall be tested as specified under the corresponding section of the Specifications and to meet local and specified requirements. Provide anemometers, thermometers, gauges, voltmeters, ammeters, and similar instruments, not part of the permanent installation, but required to record the performance of the equipment and systems. Labor, materials, power, etc .., required for testing, shall be furnished by the Contractor, unless otherwise indicated under the particular section of the Specifications.

3.2.2 Tests shall be performed in the presence of representatives of the Engineer and such other parties that have legal jurisdiction and all results shall be recorded.

3.2.3 In general, pressure tests shall be applied to piping systems only before connection of fixtures, equipment and appliances. In no case shall any piping, fixtures, equipment or appliances be subjected to pressures exceeding the ratings as prescribed by the manufacturers of fixtures, equipment and appliances, or accepted engineering standards for piping and fittings.

3.2.4 All defective work shall be promptly repaired or replaced and the tests shall be repeated until the particular system and component parts thereof receive the approval of the Engineer and authorities having jurisdiction, and at no additional cost to the Employer.

3.2.5 Any damages resulting from tests shall be repaired and/or damaged materials replaced, all to the satisfaction of the Engineer, and at no additional cost to the Employer.

3.2.6 The duration of tests shall be as determined by all parties having jurisdiction, but in no case less than the time prescribed in each division of the Specifications.

3.2.7 The following tests should be furnished for but limited to the following:

a. Noise and vibration isolation test
b. Insulation test
c. Sanitary drainage test

d. Pump tests
e. Noise and vibration measurement
f. Water heaters
g. Area storm drainage
h. Domestic water supply test
i. Steam /Condensate pipe test

3.3 Coordination of Trades

3.2.9 The Contractor shall coordinate the work to ensure orderly, timely installations of the work of applicable trades within the various spaces indicated.

3.4 Access Doors

3.4.9 Access doors shall provide ready access to concealed control valves, traps, cleanouts, motors and other items requiring operation, adjustment, or maintenance.

3.5 Permits

3.5.9 The Contractor shall obtain and pay for all necessary permits, inspections and tests, for the proper installation of his work, as may be required by the various administrative authorities having jurisdiction.

3.5.10 Certificates of inspections, tests etc., with the proper approval certified thereon, shall be secured by the Contractor and these documents shall be delivered to the Engineer before the work in question will be accepted.

3.6 Openings in Exterior Walls

3.6.1 Openings in exterior walls, particularly at or below grade shall be kept properly plugged and caulked at all times, (except when being worked on) to preclude the possibility of flooding due to storms or other causes. After completion of work, openings shall be permanently sealed and caulked in the manner herein specified.

3.7 Trench Bottom Grading

3.7.1 All trench bottom grading required for plumbing work shall be done under the requirements of this section of the Specifications. The bottom of all trenches shall be trimmed by hand method to receive pipes at their respective finish levels. Trenches shall not be excavated by machine below levels as above specified.

3.7.2 After the pipe lines have been tested and approved, backfill shall be compacted thoroughly by hand tampers below center lines of pipes and to at least 300mm above it. No backfill shall be placed in such a manner as to cause damage or misalignment to the pipes or protective coating if used. Backfill material under such conditions shall be earth or gravel above the top of piping and hubs.

End of Section 220500.

SECTION 22 05 23

GENERAL DUTY VALVES FOR PLUMBING

SECTION 22 05 23

GENERAL DUTY VALVES FOR PLUMBING

PART 1 GENERAL

1.1 General Requirements

1.1.1 Valves shall be installed only in vertical or horizontal positions unless otherwise required by the Drawings.

1.1.2 All valves shall be installed in accessible locations to facilitate easy removal for maintenance.

1.1.3 Valves shall be full-line size.

1.1.4 Valves 2 ½" (65mm) dia. and smaller shall have threaded ends, valves 3" (75) dia. and larger shall have flanged ends.

1.1.5 All threaded end valves shall be installed with unions to facilitate the removal of the valve from the pipeline.

1.1.6 Gate valves shall be installed on both sides of every piece of equipment for all pipe-system connections, and where shown on the Drawings.

1.2 Related Works Specified Elsewhere

1.2.1 The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated herein verbatim.

Section 22 0500 - General Mechanical Requirements for Plumbing
Section 22 07 00 - Plumbing Insulation
Section 22 10 00 - Plumbing Piping and Pumps
Section 22 11 10 - Facility Water Distribution
Section 22 12 00 - Facility Potable Water Storage Tanks
Section 22 13 00 - Domestic Water Softeners
Section 22 14 00 - Facility Storm Drainage
Section 22 15 00 - Compressed Air System (Non Medical)
Section 22 33 00 - Plumbing Equipment
Section 22 34 00 - Fuel Fired Domestic Water Heater
Section 22 35 00 - Domestic Water Heat Exchanger
Section 22 40 00 - Plumbing Fixtures
Section 25 50 00 - Pool and Fountain Plumbing System
Section 22 60 00 - Gas and Vacuum Systems For Laboratory & Healthcare Facilities

1.3 Valves Pressure Rating

1.3.1 Unless specified otherwise all valves, strainers, flexible connections, etc. shall be selected for pressure rating at least 1.5 times the operating pressure.

1.3.2 Contractor shall submit a schedule of all valves, strainers, etc., showing the required pressure rating for each fitting and shall indicate its location and service.

1.4 Quality Assurance and Control

1.4.1 All valves shall be kite marked to the applicable B.S. standard.
1.4.2 All valves shall be full line size.
1.4.3 All valves in steam lines shall be suitable for steam application.

PART 2 PRODUCTS

2.1 Gate Valves

2.1.1 Gate valves shall be all bronze with, non rising stem, flanged ends, bolted bonnet and bronze wedge disc faces and seats.

2.1.2 One gate valve shall be supplied and installed:

a. At the supply and return from each equipment.
b. At the discharge and suction of each pump.
c. In general at all points shown on the Drawings and/or specified.

2.1.3 Copper alloy gate valves shall conform to BS 5154.

2.2 Globe Valves

2.2.1 Globe valves shall be all bronze with, flanged ends rising stem, bolted bonnet, renewable composite disc and seat.

2.2.2 Copper alloy globe valves shall conform to BS 5154.

2.3 Check Valves (Spring Loaded Type)

2.3.1 Check valves shall be of the non-slam spring loaded, globe type with the capability to absorb and dampen the shock wave from the piping system water hammer. Check valves 2" (50 mm) and smaller, shall be all bronze, screwed ends. Valves *2W"* (65 mm) and larger, shall be cast iron, flanged ends.

2.3.2 One check valve shall be installed:

a- At the discharge of each pump.
b- At all points shown on the Drawings and/or where specified.

2.3.3 Copper alloy check valves shall conform to BS 5154.

2.4 Float Valves

2.4.1 Float valves 2" (50 mm) and smaller shall be all bronze, screwed ends, float operated. Valves 2 %" (65 mm) and larger shall be cast iron body, flanged ends, float operated. Float shall be all copper and mounted at the end of a brass or copper rod, which actuates valve operation.

2.4.2 Copper floats shall conform to BS 1968.

2.5 Automatic Air Vents

2.5.1 Supply and install all automatic air vents as shown on the Drawings and wherever specified in this book of specifications.

2.5.2 Automatic air vents of the spherical float type shall be installed at all high points in the piping. Vents shall have cast iron housing and bolted cover with gasket. Float shall be constructed of stainless steel. Vents shall be suitable for a maximum operating pressure of 150 psi (1030 Kpa). A WI (15 mm) lock shield valve shall be directly installed ahead of each automatic air vent, and a ½" (15 mm) drain line shall be provided to discharge at a convenient point.

2.6 Backflow Preventers

2.6.1 This type of valve shall be used on domestic water systems, wherever applicable.

2.6.2 Valve shall combine the double check valve protection *effect* together with an air gap venting to the atmosphere, working on the reduced pressure principle.

2.6.3 Valve shall be suitable for 125 psi (860 Kpa) steam and 200 psi (1380 Kpa).

2.7 Pipe Expansion Joints

2.7.1 Expansion joints shall be provided wherever pipes cross structural expansion joints and wherever required to prevent undue stresses caused by thermal expansion of the pipes.

2.7.2 Expansion joints shall be of the packless-bellow type with flanged or welded ends as suitable for the pipe application.

2.7.3 Bellows shall be of stainless steel and suitable for a pressure of 125 psi (860 Kpa) or the design working pressure, whichever is greater. Expansion joints shall be provided with guides to prevent any unnecessary misalignment of the pipe. Guides and anchor arrangements shall be per the recommendations of the expansion joints manufacturers.

2.8 Ball Valves

2.8.1 Valves shall be cast red bronze, ASTM B584 Alloy 845 ball type for systems other than LPG, with threaded ends, Teflon stem packing seals, Teflon seats, "T" handle for 25 mm and smaller, insulated operating lever for 30mm and larger, and blowout proof silicone bronze stem. Valves shall be rated at 2,750 Kpa water working pressure.

1.9 Balancing Valves

2.9.1 Supply and install balancing valves of double regulating effect with provision for connecting a portable differential pressure meter. Each meter connection shall have pressure temperature read out ports. Valves shall be of the Y-pattern style design which can be installed in any direction without affecting flow measurements.

2.9.2 All valves up to 2" (50 mm) shall be of copper alloy. Valves of 2 ½" (65 mm) and above shall have cast iron body with all other metal parts of nonferrous copper alloy.

2.9.3 Each valve shall provide precise flow measurement, precision flow balancing and positive shut-off with no drip seat and teflon disc.

2.9.4 Each valve shall have multi-adjustment turns of hand wheel for maximum setting with hidden memory feature to program the valve with precision tamper proof balancing setting. Number of turns shall be 4 for valve up to 2" (50 mm), 8 between 2 ½" (65 mm) and 6" (150 mm), 12 for 8" (200 mm) and 10" (250 mm) and 16 for 12" (300 mm).

2.9.5 All valves up to 2" (50 mm) shall be supplied with polyurethane container.

2.9.6 One set of computerized balancing instrument shall be supplied with the valves. The instruments shall be a read out meter, programmed with the valve curves and with a conversion formula for Cv to read the flow in gpm directly. The instrument shall also be provided with temperature measurement probe.

2.9.7 A chucking device shall hold the valve disconnect firmly and a built-in flat seal shall give it maximum tightness.

2.9.8 The valves shall be globe style design and all metal parts of non-ferrous pressure die- cast, non porous metal: copper alloy.

2.9.9 The valve shall be suitable for installing in any direction without affecting flow measurement and shall provide four functions:

- Precise flow measurement.
- Precision flow balancing
- Positive shut off with no drip seat and teflon
- disc. Drain connection with protective cap.

2.9.10 The valve shall have four 360 deg. adjustment turns of the handwheel for maximum vernier type setting with hidden memory feature to program the valve with precision tamper-proof balancing setting.

2.10 Water Pressure Reducing Valves

2.10.1 Supply and install wherever shown on the Drawings and as specified here-in-after water pressure reducing valves of the direct operated type.

2.10.2 Each valve shall be constructed of cast iron body, with stainless steel spring and shaft and nylon diaphragm.

2.10.3 The spring shall be designed to provide the pressure reduction indicated on the Drawings. The valve shall be designed for a work pressure of 1720 KPa and shall be threaded or flanged ended as the pipe connecting to it.

2.10.4 The valve shall be of the self contained type without any control lines with all internal parts being accessible by removing spring chamber and without dismantling the valve itself.

2.10.5 The valve shall be designed to operate smoothly and quietly without chattering or any water hammer problems.

2.11 Temperature and Pressure Relief Valve

2.11.1 This valve shall be used on domestic hot water lines wherever applicable.

2.11.2 Temperature and pressure relief valve shall be self-closing type with test lever and screwed connections.

2.11.3 Valve shall be suitable for a pressure of 75 to 150 psi (520 to 1030 Kpa) service and shall be supplied with temperature relief set at 210 deg.F (100 Deg.C).

2.11.4 Valve shall be AGA and ASME rated.

2.12 Strainers

2.12.1 Water strainer shall be supplied and installed at the suction connection of all pumps, and ahead of all automatic flow control valves.

2.12.2 Strainers 2 1/2" (65mm) and smaller shall be Y-pattern type with bronze body, screwed cover, brass basket and screwed ends.

2.12.3 Strainers 3" (75 mm) and larger shall be of cast iron body, brass basket and flanged ends.

2.12.4 Basket shall have *1/32"* (0.8 mm.) perforations for water service.

2.13 Flexible Connectors

2.13.1 Flexible Connectors shall be easy flexing, long cyclic life connectors, to protect mechanical equipment by relieving piping stresses, caused by piping misalignment, sagging pipe hangers, and thermal expansion.

2.14 Double Regulating Valves

2.14.1 Supply and install wherever shown on the drawing and wherever specified double regulating valves.

2.14.2 Valves 2 ½" (65 mm) and below shall be of the screwed in bonnet type of bronze construction. Stem should be rising type of brass construction. Seat shall be brass with regulating disk. Valve shall be complete with double regulating device and BS 21 taper threads (ISO R7).

2.14.3 Valves 3" (75 mm) and larger shall be of cast steel of the outside screw type. Stem shall be rising type of stainless steel. Disk up to 4" (100 mm) diameter shall be stainless and above shall be of 13% Cr. Steel. Gland shall be of stainless steel. Bonnet gasket shall be of CAF according to BS 2815 Gr A. Valve shall be complete with regulating disk, double regulating device and indicator. The valve shall be flanged to BS 4504 table *4/1.*

2.14.4 Temperature and pressure ratings shall be in accordance with BS 5160.

2.15 Accessories (Free Fall Device)

2.15.1 The valve shall be weight-operated with mercury switch devices opens on fusible link failure and shuts off the fuel oil supply pumps and the equipment is feeded by fuel oil such as boilers, incinerators, generators, etc., and so arranged that the weight falls freely, doing no work during the first part of its travel. By the time the weight is called upon to move the valve, it has accumulated sufficient momentum to overcome the inertia of the valve plug. Where pipe run is at low level special linkage should be supplied to raise lower position of dead weight to pipe centre line.

2.15.2 Required length of easy to fit non-corrosive, carefully selected stranded stainless steel cable to hold the valve open or closed as required.

2.15.3 Three brass screw hooks with brass pulleys which automatically align themselves to suit the run of the cable. Two of these shall be woodscrew thread, and one 6mm (",II) B.S.P. thread for fitting to metal surfaces.

2.15.4 Copper tube cable connectors. Where the cable has to be cut and a loop formed, these connectors shall be quick and effective.

2.15.5 One fusible link specially made to break when the temperature reaches a pre-determined point. Normally the link should made to operate at 710C (1600F) as B.S.S. 799 Part5 1975, but other temperature should be catered for when required.

2.15.6 One heavy brass wood-screw threaded eye to secure the far end of the cable to the wall or ceiling.

2.15.7 One engraved warning notice to hang on the cable to prevent people walking into it.

2.16 Thermostatic Mixing Valve

2.16.1 Valve shall be nickel or chrome plated bronze */ brass* construction, Teflon coated valve body wear surface, Teflon coated brass shuttle, EPDM O-Rings, with multiple connection alternatives either sweat union, NPT (Female) union on NPT (Female) connection compression fitting.

2.16.2 Valves shall be for domestic hot water, proportional design (simultaneous control of hot and cold water ports), straight through design (hot and cold ports at same level) ..

2.16.3 The design shall permit easy access for maintenance with replaceable thermostatic element.

2.16.4 Valves shall be capable to supply constant mixed water temperature under different working conditions, it shall have a temperature indicator for accurate control and quick set- up.

2.16.5 Valves shall be ASSE 1070 and ASSE 1017 certified and CSA approved.

2.16.6 Valves shall have the following ratings:

Temperature Range	21°C-49°C
Maximum hot water inlet temperature	100° C
Maximum pressure rating	125 PSI
Maximum Flow	10 GPM
Minimum Flow	0.5 GPM
Maximum allowable & water temperature to avoid scalding	49°C

PART 3 EXECUTION

3.1 Installation of Valves

3.1.1 Valves shall be installed only in vertical or horizontal positions unless otherwise required by the Drawings.

3.1.2 All valves shall be installed in accessible locations to facilitate easy removal for maintenance.

3.1.3 Valves shall be full-line size.

3.1.4 Valves 2" (50 mm) dia. and smaller shall have threaded ends, valves 2 %" (65 mm) dia. and larger shall have flanged ends.

3.1.5 All threaded end valves shall be installed with unions to facilitate the removal of the valve from the pipeline.

3.1.6 Gate valves shall be installed on both sides of every piece of equipment for all pipe- system connections, and where shown on the Drawings.

3.2 Approved List of Manufacturers

3.2.1 For acceptable Products, Manufacturers and Suppliers, refer to Appendix A.

End of Section 22 05 23.

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING

PART 1 GENERAL

Works of this Section shall be governed by Conditions of Contract and it's requirements.

1.1 **Hangers and Supports, Anchors and Guides - General**

1.1.1 Support, anchor and guide all piping to preclude failure or deformation. Construct and install hangers, supports, anchors, guides and accessories to the approval of the Engineer. Do not use wire, tape or metal bands. Supports shall. be designed to support weight of pipe, weight of fluid and weight of pipe insulation.

1.1.2 Fasten piping securely to the structure without overstressing any portion of the supports or the structure itself. Secure pipe support, anchors and guides to concrete by means of inserts or if greater load carrying capacity is required by means of steel fishplates embedded in the concrete.

1.1.3 Arrange hanger to prevent transmission of vibration from piping to building and supports.

1.1.4 Un-insulated copper or brass pipe and/or tubing shall be isolated from ferrous hangers or supports

1.1.5 Support piping and tubing at intervals indicated in the schedule hereinafter and at all changes in direction. Maximum deflection shall not exceed 3 mm.

1.1.6 Clearance for application of specified Vapour sealed insulation without cutting pipeline covering or fitting covering in installation of pipe hangers and fittings shall be provided.

1.1.7 Furnish pipe hangers and supports complete with rods, bolts, lock nuts, swivels, couplings, brackets and all other components and accessories, to allow installation to freely expand and contract.

1.1.8 Provide trapeze hangers where several pipes can be installed parallel and at the same level. Trapeze shall be of steel channel sized to support load and drilled for rod hanger at each end. Provision should be made to keep the lines in their relative position to each other by the use of either clamps or clips.

1.1.9 For hanger rods on piping 3/8" (10 mm) thru 2" (50 mm) inclusive use 3/8" (10 mm) rods, and for piping 2 WI (65 mm) thru 5" (125 mm) use 5/8" (16 mm) rods, and for piping 6"(150 mm) thru 12" (300 mm) use 7/8" (22 mm) rods.

1.1.10 Provide additional steel members required for hanging piping systems in areas with special conditions, or where vertical or horizontal structural steel supports are required other than those provided in the structure.

1.1.11 Provide lateral bracing for supporting rods over 450mm. long braced at every fourth hanger with diagonal bracing attached to slab or beam.

1.1.12 Floor supports - provide for supporting horizontal piping from floors with cast-iron rests, with pipe nipples to suit. Fasten to floor. Where provision for expansion is required, provide pipe roll stands, without vertical adjustment. Provide concrete or steel pipe piers, fasten stands to piers.

1.1.13 Wall supports - provide for supporting horizontal piping from wall with steel J-Hook for pipe located close to wall and not larger than 3" (80 mm) pipe. For greater loads, up to 1500 Ibs (680 Kg) maximum loading provide welded steel bracket.

1.1.14 Provide oversize hangers with blocking the same thickness as the insulation to pitch vapor sealed insulated pipes accurately at time of insulation.

1.1.15 Hangers on PVC pipes shall be of design which does not clamp the pipe tightly but permits axial movement.

1.1.16 Support but do not rigidly restrain PVC pipes at end of branches and at change of direction or elevation. Vertical piping shall be maintained in the straight alignment. Support trap arms in excess of 900mm in length as close as possible to the trap.

1.2 Horizontal Piping Support Schedule

1.2.1 Steel and PVC Pipes

- ¾" and 1" (20 and 25 mm) steel pipe-----2.5 meter
- 1 X"-2" (32 and 50 mm) steel pipe-------3.0 meter
- 2 ½"-4" (65 and 100 mm)steel pipe ------4.0 meter
- 5"-6" (125 and 150 mm) steel pipe---------5.0 meter
- 2 ½' (65 mm) and smaller PVC pipe-------1.2 meter
- 3" (80 mm) and over PVC pipe-------------1.8 meter

1.2.2 Vertical spacing of PVC pipes shall be twice as those of horizontal spacing.

1.2.3 Vertical spacing of other pipes - at every floor level.

End of Section 22 0529.

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING

Part 1 GENERAL

1.1 Introduction

1.1.1 Work of this Section to be read and governed by General Conditions of Contract. This Section includes Painting and Identification of all pipe works, equipment etc.

1.2 Scope of Work

1.2.1 The Contractor shall be responsible for submitting complete above works based on specifications and consultant's approval of samples.

1.3 Related Works Specified Elsewhere

1.3.1 The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated herein verbatim.

Section 22 0500 General Mechanical Requirements for Plumbing
Section 22 1000 Plumbing Piping and pumps
Section 22 30 00 Plumbing Equipment
Section 225000 Pool and Fountain Plumbing System

1.4 Reference Standards

BS 1710	Identifications of Pipe Lines and Services
BS 4800	Paint Colours for Building Purposes

Part 2 PRODUCTS

2.1 **Valve Chart Locations**

2.2.1 Valve charts shall be provided for each piping system and shall consist of schematic Drawings of piping layouts, showing and identifying each valve and describing its function. Two copies of each chart, sealed to rigid backboard with clear lacquer placed under glass and framed, shall be mounted in the building as directed by the Engineer.

2.2 Identification of Pipelines and Services

2.2.1 General

2.2.1.1 All Building Services, piping and their covering shall be properly identified with low emission material as per GREEN/ LEED Guidelines in accordance with BS 1710, Latest Edition.

2.2.1.2 All methods of identification shall be compatible with the pipe and operating conditions.
2.2.1.3 Identification shall be accomplished by using basic identification colours with code indications.

2.2.1.4 Code indication shall include safety colours and service information. Information shall be given regarding the nature of the contents of the pipe by using the following systems, individually or in combination:-

i. Name in Full
ii. Abbreviation of Name
iii. Chemical Symbol
iv. Appropriate Code Indication Colour bands.

2.2.2 Legend

2.2.2.1 The material in piping system shall be identified. Primary identification should be by means of a lettered legend naming the material conveyed by the piping in full or abbreviated form. Arrows shall be used to indicate the direction of flow.

2.2.2.2 The legend shall be brief, informative, pointed, and simple. Legends shall be applied close to valves and adjacent to changes in direction, branches, where pipes pass through walls or floors and as frequently as needed along straight runs to provide clear and positive indication. Identification maybe applied by stenciling, tape or markers.

2.2.2.3 Pipe marking should be highly visible.

2.2.3 The Type & Size of Letters

Outside Diameter of pipe or covering (mm)	Length of colour field (mm)	Height of letter (mm)
(13 to 32)	200	13
(40 to 50)	200	19
(65 to 150)	300	32
(200 to 250)	600	63
Over 250	800	100

2.2.4 Colour

2.2.4.1 The Colour should be shown on the piping, but in combination with a legend. The application of colour bands shall be done by: Painting, Adhesive colour bands or equivalent colour clips. Colour reference shall be in accordance with BS 4800, Latest Edition.

2.2.5 Color Code Indication for Building Services and Pipelines should be as follows:

		Basic Colour	Colour Code Identification
-	Cold Water	Green	Blue
-	Hot Water	Red	Green/White
-	Drainage	-	Black
-	LPG or Natural Gas	-	Yellow
-	Steam	Silver	Grey

2.3 **Sign and Accessory Fastening**

2.3.1 Warning and instruction signs, wherever specified or otherwise required, shall be securely fastened where shown or directed with bolting anchors herein specified for masonry construction or round head chrome plated brass wood screws and washers for wood construction. Signs shall not be hung loose on chains or by any other method wherein the sign will be free to move. Sign shall be installed in a conspicuous well lighted location adjacent to the equipment it refers to and shall be easily read by occupants in standing position on floor.

2.3.2 All accessories such as wrenches specified to be hung on chain adjacent to the equipment they serve, shall be arranged for stowing in a rigid manner and shall not be hung loose, or otherwise, that may permit the chain or wrench to move or rattle.

2.4 Nameplates

2.4.1 Each unit of equipment shall be identified by a permanently attached nameplate made of brass or other corrosion-resistant metal. Plates shall be not less than forty (40) by eighty (80) mm. Plates shall bear information pertaining to the unit as follows:

a. System and unit designation from schedule of equipment.
b. Manufacturer's name and address.
c. Serial and model number.
d. Rated capacity.
e. Temperature, pressure or other limitations.

2.5 Painting

2.5.1 General Requirements

2.5.1.1 Surface requiring prime painting shall be cleaned thoroughly of all rust, loose scale, oil, grease and dirt. Use wire brushes and solution for this purpose.

2.5.1.2 No painting shall be applied to damp or frosty surfaces in wet, foggy or freezing weather.

2.5.1.3 int shall be evenly spread and well brushed out so that there shall be no drops, runs or sagging.

2.5.1.4 Shop coated surfaces shall be cleaned thoroughly and retouched where necessary.

2.5.1.5 Care shall be taken not to paint controls, label plates, nameplates on all apparatus and non-ferrous refrigerant piping.

2.5.1.6 All items that have rusted or corroded in storage or in place shall be re-cleaned or repainted upon request of the Engineer.

2.5.1.7 Finishing coats shall be made in accordance with a color code, based on ASHRAE or BS recommendations after being submitted to and approved by the Engineer.

2.5.2 Machinery

2.5.2.1 All machinery installed under this contract such as motors, pumps, etc. shall have a shop priming coat of gray lead and oil.

2.5.3 Piping

2.5.3.1 All un-insulated and unwrapped Ferrous piping (galvanized or non-galvanized) including flanges, bolts and valves in trench, partitions, below tiles, or underground shall be painted with 2 coats of emulsified asphalt.

2.5.3.2 Paint all exposed (in shafts, above and below false ceiling, on roof, etc ..) ferrous piping (including galvanized steel) system components including pipe, fittings, unions, flanges, valves, hangers and supports as follows before wrapping or insulating the pipes (if applicable).

2.5.3.3 Applicable to galvanized pipes:

a. Prime Coat: Zinc Chromate.
b. Finish Coat: Ironhide gray metal paint or as approved by the Engineer.

2.5.3.4 Applicable to all other ferrous pipes:

Prime Coat: Red lead Primer, 1.5 to 2.0 mils thick.

2.5.4 Iron Work

2.5.4.1 All iron work within the building, not otherwise specified such as pipe and duct hangers and supports, and supports for apparatus, shall be prime painted with one coat of red lead.

End of Section 22 05 53.

SECTION 22. 07 00

PLUMBING INSULATION

PART 1 GENERAL

PART 2 PRODUCTS

PART 3 EXECUTION

SECTION 22 07 00

PLUMBING INSULATION

PART 1 GENERAL

Works of this Section shall be governed by Conditions of Contract and SECTION 22 05 00, requirements.

1.1 Scope of Work

1.1.1 Supply and install all insulation and lagging on piping, vessels as indicated on the drawings or specified to be insulated.

1.1.2 All insulation material shall have Zero Ozone Depletion Potential (ODP) and less than Five Global Warming Potential (GWP < 5).

1.1.3 Canvas jacket and all insulating materials shall be non-combustible, or self-extinguishing non-flame spread grade.

1.1.4 Insulation in exposed areas, i.e. permanently visible, shall be protected with aluminium cladding as specified herein after.

1.2 Related Works Specified Elsewhere

1.2.1 The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated herein verbatim.

Section 22 0500 - General Mechanical Requirements for Plumbing
Section 22 10 00 - Plumbing Piping and Pumps
Section 22 30 00 - Plumbing Equipment
Section 25 50 00 - Pool and Fountain Plumbing System

1.3 Schedule of Insulation Thickness

1.3.1 The thickness of the insulation applied to pipes and equipment shall be as follows:-

Service	Location	Pipe Diameter inches (mm)	Insulation Thickness inches (mm)
Boiler, Water Tanks, and Hot water Pumps	-	-	2 (50)
Domestic Cold water Pipes running exposed to sun	-	All sizes for cold water and only larger than 3 (80 mm) for hot water pipes	1(25)
Steam Pipes	-	-	2 (50)
Condensate Steam Pipes	-	-	1 ½(38)
Domestic hot and return Water Pipes	-	Up to 3 (80)	1 (25)

1.4 Codes and Standards

1.4.1 Codes and standards applicable to this section shall be primarily British Standards and United States Codes, unless otherwise specified, the performance/manufacturing standards of items mentioned in this section shall confirm to the applicable portions of the latest editions of codes, standards and regulations.

Reference Code	Abbreviation	Applicable Standard	Title of Standard
National Fire Protection Association	NFPA	NFPA 90A	Standard for Air Conditioning and Ventilating Systems
		NFPA 90B	Standard for warm Air Heating and Air Conditioning Systems
American Society for Testing and Material	ASTM	ASTM E96	Test method for water vapor transmission of materials

PART 2 PRODUCTS

2.1 Pipe Installation

2.1.1 Before installation, the pipe shall be inspected for defects. Defective, damaged or unsound pipe will be rejected. Deflections from a straight line or grade, between the center lines extended, of any 2 connecting pipes made necessary by vertical curves or horizontal curves or offsets, shall not exceed 12500/ D mm. per linear meter of pipe, where D represents the nominal internal diameter of the pipe expressed in millimeters. If the alignment requires deflections in excess of these limitations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set forth. Except where necessary in making connections with other lines, pipe shall be laid with the bells facing in the direction of laying. Pipes in trenches-Place each length of pipe with a uniformly distributed bearing for the bottom 0.3 of the pipe on the sand fill in the trench. Excavate recesses to accommodate pipe bells, sleeves, glands or other fittings. Take up and re-lay any pipe that has the grade or joint disturbed after laying. Clean the interior of the pipe of all foreign material before lowering into the trench, and keep clean during laying operations by means of plugs or other acceptable methods.

2.1.2 All drainage and rain water pipes running underground, under the building, shall be encased in concrete for the whole length.

2.2 Pipe Insulation - Type A

2.2.1 This type of insulation shall apply to cold water pipes running on roof and to domestic hot water.

2.2.2 Insulation shall be flexible foamed closed cell elastomeric tublar form type. Insulation may be slipped over pipe or tubing before pipe connections are made, or may be slit longitudinally and snapped onto the pipe and then sealed with vapour barrier adhesive.

2.2.3 Insulation shall have a thermal conductivity not greater than 0.27 BTU / Hr OF. ft sq. per inch thickness at a mean temperature of 75 ° F.

2.2.4 The surface finish shall be an 8-ounce canvas cloth embedded between 2 coats of vapour barrier. Aluminium cladding shall be provided as specified.

2.3 Pipe Insulation - Type B

2. 3.1 This type of insulation shall apply to diesel engine flue pipe.

2. 3.2 Pipe insulation shall be preformed rigid section fibrous glass molded in cylindrical form to fit snugly, sectional one piece construction, with a density of not less than 4 Ibs/ft3 (65 kg/m3) and a max. K-factor of 0.25 Btu.in/Ft2 hr. OF (0.036 W/m.°K) at a mean temperature of 75°F (24°C) side and end laps of jacket shall be pasted down with lapping cement and secured with aluminum bands using a minimum of three bands per block.

2.4 Aluminum Cladding

2. 4.1 Aluminum cladding shall be of 20 gauge, it shall be used as protection against weather and mechanical damage.

2. 4.2 Aluminum cladding shall be applied on top of insulation above the canvas jacket and vapour barrier coating. It shall be held in place by means of self tapping screws and by using 38 mm wide aluminum straps at 300 mm centers with aluminum or stainless steel angle rib clips, all joints shall be sealed with grey coloured suitable sealant. Rivets and screws shall not be used for cladding unless approved by the Engineer for use on elbows and fittings. Cladding shall be overlapping at joints, horizontal seams shall be at the bottom. Cladding on ducts shall be formed in such a way to allow for rain/dew drain *off.*

2. 4.3 Fabricated 20 gauge aluminum covers shall be used for valves and fittings. The covers shall

be in two sections hinged together and held in place by suitable stainless steel/aluminum clasps.

2. 4.4 Aluminum cladding shall be applied to all insulated pipes (Galvanized and Pre-insulated) running exposed on roof, outside building, inside parking floors and in plant rooms.

2.5 Protective Coating & Wrapping (Fuel Oil Piping)

2.5.1 Surfaces of pipes shall be thoroughly cleaned to remove rust, millscale, direct and other loose matter. After the surface is clean and dry, one continuous coat of primer (quick drying) shall be applied and allowed to dry completely. After the surface is fully dry, wrap the pipes with pipeline corrosion tape with backing of black colour or other similar approved wrapping material. Longitudinal overlap should be 25 mm or greater according to the specification and end laps a minimum of 150 mm. Prior to wrap over the fittings, approved moulding putty shall be applied.

2.6 Pipe-covering (insulation) protection saddles.

2.6.1 Provide hanger shields to protect vapor sealed pipe insulation within mechanical equipment rooms at each support point by a 360 degree insert of high density, 100 psi, waterproofed calcium silicate encased in a 120 deg..sheet metal shield. Insert thickness shall be same as insulation. Shield length shall equal nominal pipe dia., minimum but shall not be shorter than 100mm and need not be longer than 300mm if 6 bearing load causes no discernable deformation. Insert shall extend 25mm beyond sheet metal shield.100mm shields shall be 26 gauge minimum. Shields 130 to 230mm long shall be 20 gauge minimum. Shields longer than 230mm shall be 16 gauge.

2.6.2 Provide penetration shields to encase insulated pipes penetrating fire walls or floors in a 360 deg., 24 gauge minimum sheet metal hanger shield with insert of high density, 100 psi. waterproofed calcium silicate the same thickness as insulation and further enclosed within the sleeve, sized for maximum 25mm. spacing between sleeve and insulation shield, pack annular space between sleeve and shield on both ends with double neoprene coated asbestos rope. Install an escutcheon plate to completely cover the wall penetration opening and fit snugly over the pipe insulation shield. Insert shall extend at least 25mm. beyond penetrated surface and escutcheon.

2.6.3 Provide oversize hangers with blocking of the same thickness as the insulation to pitch vapor sealed insulated pipes accurately at time of insulation.

2.7 Pipe Sleeves

2.7.1 Sleeves shall be provided for pipes passing through walls, floors and partitions and be of similar material to pipe except for plastic pipes where sleeves shall be copper or steel.

2.7.2 Sleeves shall be generally one or two sizes larger than pipe as necessary and positioned true with pipe to provide adequate clearance and also allow for lateral movements of pipeline if required.

2.7.3 Sleeves shall be finished flush with finishes face of wall, floor and ceilings, but project 75 mm above floors in wet areas with the cap sealed with waterproof mastic.

2.7.4 Sleeves shall be firs-stopped in gap between pipe and sleeve in all fire rated structures to Building Regulation E14 using asbestos-free fire proof material and without restricting pipework movement (with any thermal insulation sections stopped short each side).

2.7.5 Sleeves shall be caulked in gap between pipe and sleeve in external walls using asbestos-free, weather and vermin proof material.

2.8 Equipment Insulation

2.8.1 This type of insulation shall apply to boilers, boiler circulator, pumps, heat exchangers hot water expansion tanks and domestic hot water tanks.

2.8.1.1 Insulation shall be semi-rigid fibrous glass with organic binder up in board form with a minimum density of 3 lbs/ft3 (50 kg/m^3) and a maximum K-factor of 0.42 Btu-in/ftz.hr.T (0.06 W/m. °K) at a mean temperature of 200 0F (94°C). Insulation shall be applied over pins welded to the vessel on 300 mm centers. All joints shall be staggered and tightly butted. The insulation shall be covered with gauge 18 aluminium jacket.

PART 3 EXECUTION

3.1 Protection and Cleaning

3.1.1 All insulation shall have a smooth, homogenous and lineable finished surface. All rigid sections shall be concentric and be accurately matched for thickness.

3.1.2 All surface to be insulated shall be dry and free from loose scale, dirt, oil or water when insulation is applied.

3.1.3 No surface imperfections in the insulation such as damaged edges, or ends, cracks and small voids or holes shall be accepted.

3.1.4 Insulation materials shall be stored and protected from weather moisture, accumulations of foreign matter, or possible damage in a dry and clean store.

3.1.5 Surface finishes and lagging adhesives shall not be diluted and shall be applied in accordance with the manufacturer's instructions.

3.1.6 Apply insulation to permit expansion or contraction of metal without causing damage to insulation or surface finish.

3.2 Installation of Piping

3.2.1 All pipe covering 2 ½'' (65 mm) or less in thickness shall be applied in single layer with joints tightly butted together.

3.2.2 All pipe covering 3" (80 mm) and larger in thickness shall be double layer with lateral and longitudinal joints of the second layer staggered with those of the first layer. No canvas is to be used between the layers.

3.2.3 All pipe covering shall fit snugly on the pipe to which it is applied. Inside circumference of pipe covering when applied shall not vary from the outside circumference of the pipe by more than 3mm. undersize.

3.2.4 Pipe insulation shall have factory applied jackets and secured with plastic bands at each joint at center of each section and where sections abut upon fittings, except where otherwise specified.

3.2.5 Insulation shall only be applied to piping after all testing has been accomplished and after all the coats of paint have been applied.

3.2.6 Pipe covering shall be terminated at a sufficient distance from all flanges to permit easy removal of bolts.

3.2.7 Screwed, soldered, and welded fittings and valves (up to the bonnet) on 4"(100mm) pipe and larger, shall be insulated with block insulation or pipe covering and shall be given a trowelled coat of finish cement to present a smooth surface. Valves shall be covered to the gland.

3.2.8 Screwed, soldered, and welded fittings and valves (up to the bonnet) up to 4"(100mm) in size shall be covered with field fabricated metered segments of pipe insulation equal in thickness to the adjoining insulated pipe and finished with standard weight canvas jacket. Where hangers are installed on the pipe covered with insulation the entire hanger up to the rod shall be insulated.

3.2.9 Where insulated piping is subject to movement and supported on roller hangers, steel protection saddles shall be provided and welded to the pipe. Saddles shall be filled with asbestos cement.

3.2.10 All insulated piping not supported on roller hangers and subject to movement, shall be provided with protection shields at all hanger locations. Shields shall be of 3mm. galvanized iron extending on each side of the hanger for a distance equal to the diameter of the insulation and shall extend up the sides of the insulation to the center of the pipe and shall be provided with cork pad support.

3.2.11 Where standard insulation shapes are not available, cut, score or meter segmental or flat block to fit contour of pipe, stagger joints of adjoining segments. Fit insulation carefully and secure with wire. Smooth with insulating cement.

3.2.12 Insulate valves, strainers, fittings and flanges with identical material, density, thickness and finish as the piping insulation. Use pre-molded insulation material where available, otherwise use shaped block segments wire on with all edges filled with insulation cement or filler.

3.2.13 Insulate strainers to permit removal of the basket without disturbing the insulation of the strainer body.

3.3 Finishes

3.3.1 All pipes running in concealed spaces shall have canvas cover, securely fixed, overlaps firmly pasted down, secured with aluminum bands at intervals and painted with two coats of fire retardant emulsion paint.

3.3.2 All non-c1added pipes running inside building but exposed to view shall have same treatment as for those in concealed spaces but with one coat of gloss paint, to an approved colour, in addition.

3.3.3 Insulation in exposed areas, i.e. permanently visible, shall be protected with aluminum cladding as specified.

3.4 Approved List of Manufacturers:

3.4.1 For accepted products, Manufacturers and suppliers, refer to Appendix A.

<u>End of Section 220700.</u>

SECTION 221116

DOMESTIC WATER PIPING AND FITTINGS

PART 1 GENERAL

PART 4 PRODUCTS

PART 3 EXECUTION

SECTION 221116
DOMESTIC WATER PIPING AND FITTINGS

PART 1 GENERAL

1.1 Introduction

1.1.1 Works of this Section shall be governed by Conditions of Contract and Section 22 05 00.

1.1.2 This section describes basic materials and requirements for Pipework services installations for building.

1.2 Related Works Specified Elsewhere

1.2.1 The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated herein verbatim.

Section 22 05 00 - General Mechanical Requirements for Plumbing

Section 22 07 00 - Plumbing Insulation

Section 22 10 00 - Plumbing Piping and Pumps

Section 22 30 00 - Plumbing Equipments

Section 22 40 00 - Plumbing Fixtures

Section 25 50 00 - Pool and Fountain Plumbing System

Section 22 60 00 - Gas and Vacuum Systems for Laboratory & Healthcare Facilities

1.3 Storage of UPVC Pipes

1.3.1 PVC pipe and fittings shall be stored under cover at all times. Sun liqht shall not be permitted to come into contact with the PVC materials at any time, except during installation in trench. The pipes shall be stored on flat level ground free from large or sharp edged stones or objects, and shall be stacked to a maximum height of 1.5 m. (or as recommended by the manufacturer) with sockets at alternate ends, and in such a manner as to prevent sagging or bending.

1.4 Pipe Identification

1.4.1 All pipes shall be indelibly marked at intervals of not greater than 3m. The marking shall show the manufacturer's identification, the standard name and number, and the nominal size and class. Adhesive labels alone shall not suffice. All pipes complying with British Standards shall be kitemarked.

1.5 Arrangement and Alignment

1.5.1 Install piping in a neat, workmanlike manner and the various lines shall be parallel to building walls wherever possible.

1.5.2 Install pipe groups for plumbing parallel with pipes of other trades.

1.5.3 Space pipe supports, arrange reducers and Pitch piping to allow air to be vented to system high points and to allow the system to be drained al the low points. However, where obstructions exist, automatic air vents shall be installed at all air pocket points and *1/2"* (15 mm) drain gate valves shall be supplied and installed at all low points and riser legs.

1.6 Storage

1.6.1 PVC pipe and fittings shall be stored under cover at all times. Sun light shall not be permitted to come into contact with the PVC materials at any time, except during installation in trench. The pipes shall be stored on flat level ground free from large or sharp edged stones or objects, and shall be stacked to a maximum height of 1.5 m. (or as recommended by the manufacturer) with sockets at alternate ends, and in such a manner as to prevent sagging or bending.

1.7 Codes and Standards

1.7.1 Codes and standards applicable to this section shall be primarily British Standards and United States Codes, unless otherwise specified, the performance/manufacturing standards of items mentioned in this section shall confirm to the applicable portions of the latest editions of the following codes, standards and regulations.

Reference Code	Abbreviation	Applicable Standard	Title of Standard
American Water Works Assosiation	AWWA	C601-68 C501-67 M45	FIBERGLASS PIPE DESIGN MANUAL
American Society for Testing and Materials	ASTM	ASTM C425	Specification for compression joint for vitrified clay pipe and fittings
		ASTM A53-88a	Specification for pipes, steel, black and Hot-Dipped, Zinc-Coated, Welded and Seamless
		ASTM B88	Specification for Seamless copper water pipe
		ASTM B280-88	Specification for Seamless copper tube for A/C and refrigeration field Service
		ASTM A307	Specification for Carbon Steel Bolts and Studs. 60,000 psi tensile Strength
		ASTM D1785	Specification for poly (vinyl chloride) (PVC) plastic pipe schedules 40, 80, and 120.
		ASTM D3517M	Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermo-Setting-Resin) Pressure Pipe.
American Standards Association	ASA	ASA 40.1	-
		ASA B16.22	-
		ASA B1618	-
		ASA B9.1	-
		ASA B35.5	-
British Standards	BS	BS 4514	Specification for unplasticized PVC soil and venting pipes, fittings and accessories.
		BS 5255	Specification for thermoplastics waste pipe and fittings.

		BS 5254	Specification for polypropylene waste pipe and fittings (external diameter 34.6 rnm, 41.0 mm and 54.1 mm)
		BS 3505	Specification for unplasticized polyvinyl chloride (PVC-U) pressure pipes for cold potable water
		BS 4346 Part 1	Joints and fittings for use with unplasticized PVC pressure pipes. Injection moulded un plasticized PVC fittings for solvent welding for use with pressure pipes, including potable water supply.
		BS4346 Part 2	Mechanic joints and fittings, principally of unplasticized PVC.
		BS 4660	Specification for unplasticized polyvinyl chloride (PVC-U) pipes and plastics fittings of nominal sizes 110 and 160 for below ground gravity, drainage, and Sewerage
		BS 5480	Specification for Glass Reinforced Plastic (GRP) Pipes, Joints and Fittings for use of Water Supply or Sewerage.
		BS 5481	Specification for unplasticized PVC pipe and fittings for gravity sewers
		BS 1387	Specification for screwed and socketed steel tubes and tubular and for plain and steel tube suitable for welding or for screwing to BS21 p
		BS 2871	Specification for copper and copper alloys, tubes.
		BS 864 PART 2	Specification for capillary and compression fittings for copper tubes.
		BS 3601	Specification for carbon steel pipes and tubes with specified room temperature properties for pressure pipes.
		BS 21	Specification for pipe threads for tubes and fittings where pressure light joints are made on the threads.
American Society for Heating, Refrigeration, and Air Conditioning Engineers	ASHRAE	-	-
Deutches Institute for Normung	DIN	DIN 19534	-

American National Standards Institute	ANSI	ANSI B18.2.2
		ANSI B31.1
		ANSI A21, 10, 11 -

PART 2 PRODUCTS

2.1 UPVC Pipes - Type 2

2.1.1 UPVC pipes-Type 2 (Un-plasticized Polyvinyl Chloride) pipes shall be to BS 3505 latest edition Class E 15 Bar (1500 Kpa) working pressure at 68° F (20° C) fluid temperature and 103° F (40° C) ambient temperature or ASTM specification 0 1785 Schedule 40 for inside the buildings, and as per ASTM specification 01785 schedule 80 for the risers.

2.1.2 The pipe shall be homogenous throughout and free from visible cracks, holes, foreign inclusions or other defects. The pipe shall be as uniform as commercially practicable in color, opacity, density and other physical properties.

2.1.3 All fittings and accessories shall be of same material and quality as the pipe and jointing up to 2 W' diameter shall be of the spigot and socket cemented type where solvent cement is applied to both parts all in compliance with B.S. 4346: Part I: 1969 joints and fittings for use with un-plasticized PVC pressure pipes, Part I : Injection moulded PVC PVC fittings for solvent welding for use with pressure pipes. After pushing the pipe into the socket, the joint shall be allowed to set for at least 10 hr.

2.1.4 Jointing for all pipes buried underground outside buildings and for all pipes above 3" diameter shall be of the rubber ring integral socket type to BS 4346 Part 2.

2.1.5 Expansion joints with guides as recommended by manufacturer shall be installed on long run solvent cemented pipes every 30 meters of length, and wherever shown in the specification.

2.1.6 Bending PVC pipes is only allowed in non-critical application at room temperature and after the approval of the Engineer.

2.1.7 Before bending, the pipe should be heated at the section to be bent to a temperature of about 275-300° F (135-150° C).

2.1.8 The bore should be supported by packing with sand or by insertion of thick rubber pipe, the heating being carried out in a hot air oven or by immersion in hot oil or glycerine. Overheating should be avoided, and the pipe should not be held at the bending temperature too long.

2.2 Cross Linked Polyethylene Pipes (XLPE)

2.2.1 XLPE piping system shall be basically consist of the following components:

2.2.1.1 Cross linked polyethylene pipe pulled in coloured (red for hot water blue for cold water application) corrugated conduits of polyethylene material.

2.2.1.2 Ring main line fittings and valves of bronze or DZR brass construction.

2.2.2 <u>Pipes</u>

2.2.2.1 The inner pipe shall be made of cross linked polyethylene which can withstand upto 95 degree C fluid temperature inside it at a maximum pressure of 10 bars. Pipes shall be able to withstand short time temperature loading upto 110 degree C at a maximum pressure of 10 bars.

2.2.2.2 All pipes shall be stamped at equal intervals with clear marks showing clearly the name of the manufacturer along with the pressure and temperature ratings, pipe diameter and wall thickness, pipe standard DIN *16892/93* and the country of origin of manufacturer.

2.2.2.3 All pipes shall be laid so that they can be easily replaced, whenever necessary by fast and easy pulling from the conduits.

2.2.2.4 Pipes shall satisfy the requirement for drinking water installation and approved by a recognized health organization DVGW or equivalent whenever specifically intended for potable application.

2.2.3 Conduits

2.2.3.1 The conduits shall be made of temperature stabilized high density polyethylene and shall be capable of retaining its form upto 105 degree C. Conduits shall have different colour for different application.

2.2.4 Fittings & Accessories

2.2.4.1 One single line XLPE pipe in one single conduit will supply water to one fixture only from a main ring above false ceiling.

2.2.4.2 Ring feed line shall have an isolating valve of bronze construction. Each pipe at its termination above false ceiling shall be labeled with a tag indicating the fixture it is supplying.

2.2.4.3 Pipes to be connected to the different fittings via a special wall box of reinforced plastic fitted with bronze or DZR brass elbow suitable for "'/2" or :y,." threaded connection as required. The box should be suitably designed in order to enable the replacement of existing pipes in the event of their damage (puncturing).

2.2.4.4 All valves, wallbox, elbows, tees, bends should be of bronze or DZR brass connections to be of a cone grip unions type allowing full flow capacity, minimum pressure loss, easily detachable with torque clearly defined for a fool proof installation.

2.2.4.5 Contractor to use proper tools for assembly as recommended by manufacturer, i.e. assembly pliers, Ratchet torque wrench, cutters, etc.

2.2.4.6 Distribution ring shall be located above the false ceiling as indicated on the drawings.

2.3 Polypropylene Pipes (PP-R)

2. 3.1 Polypropylene Copolymer Random (PP-R) pipes shall be manufactured according to DIN 8077/8078, fittings shall be manufactured according to DIN 16962.

2. 3.2 Pipes and fittings shall be jointed using electro-fusion welding process. Welding shall be made as recommended by the manufacturer. Threaded fittings shall be used to connect to other piping systems, fixtures, etc., fitting with melal insert shall be sealed with Teflon tape.

2. 3.3 PP-R pipmq system shall be installed with special pre-caution for thermal expansion especially for exposed installation.

2. 3.4 Thermal expansion shall be compensated by use of proper elbows, fittings, as recommended by The manufacturer.

2. 3.5 PP-R pipes shall not be installed or stored under direct UV light. Pipes in shafts and roof shall be ot multi-layer PP-R aluminium consisting of main pipe PP-R coated with aluminium toil and covered with PP-R film treated to resist long time exposure to UV light. Pipes on roof shall be insulated and cladded.

2. 3.6 Pipe bending shall be generally avoided, in extreme cases pipes may be bent by heating with hot air without direct flames. The minimum bending radius shall be 8 times the pipe diameter.

2. 3.7 PP-R pipes and fittings shall be certified for potable water use by a recognized European Standard, DVGW or approved equivalent.

2. 3.8 Pressure rating of pipes and fittings shall be PN 25. Pipes shall be suitable for working pressure of 10 bars at a working temperature of 60 degree C.

2.4 Flanged Pipe Joints

2.4.1 All flanged joints shall be made up with compressed ring type asbestos gaskets. Gaskets shall be 1.5 mm. thick.

2.4.2 Bolts for flanges shall be of low carbon sleel with hexagonal heads and hard pressed steel hexagon nuts. Bolts shall be to ASTM specifications A 307 or SAE grade 2, with tensile strength of 64000 psi (441.3 Mpa) minimum.

2.4.3 All bolt holes shall be spot faced.

2.5 Joints between Dissimilar Materials

2.5.1 Screwed Pipe to Cast Iron Pipe

2.5.2 Joints between wrought-iron, steel, brass or copper pipe and cast iron pipe shall be made with cast iron spigots screwed to the steel pipe and caulked to the cast iron pipe.

2.5.3 Copper Tubing to Screwed Pipe Joints

2.5.4 Joints shall be made by the use of brass converter fittings. The joint between the copper pipe and the fitting shall be properly soldered, and the connection between the threaded pipe and the fitting shall be made with a standard pipe size screw joint.

2.6 Joints Between Dissimilar Metals (Dielectric isolators)

2.6.1 Make joints between ferrous and non-ferrous screwed piping and equipment by using Teflon or nylon isolating materials in the form of screwed unions.

2.6.2 Make joints between ferrous and non-ferrous flanged piping and equipment with insulating gaskets and "Teflon sleeves and washers between flanges, bolts and nuts.

2.6.3 The entire insulating joint including the dielectric material shall be suitable to withstand the temperature, pressure and other operating characteristics for the service for which they are used.

2.7 Fire Stop Collar

2.7.1 Supply and install factory manufactured fire stop collar for all the plastic pipes penetrating fire rated walls and floors. The Collar should be of heavy gauge galvanized metal to house the in tumescent insert. The intumescing shall provide a minimum of ·15 times the free expansion and shall contain no water soluble expansion ingredients and approved to be used in combination with the smoke sealant from the same manufacturer. The collar should be UL classified and FM systems approved to the requirements of ASTM E814 (UL 1479).

2.7.2 The fire sealant should be of non hardening compound, non water soluble ingredients, capable of expanding a minimum of 5 times when subjected to 230 degree F to 100^{o} F. The sealant should be UL classified and FM system approved to the requirements of ASTM E814 (UL 1479).

2.8 Piping Schedule

2.8.1 General

2.8.2 Piping classes are specified for each service in the following schedule. The designations indicated refer to detailed specifications for piping in this section of the specifications:

2.9 Hose Bibs

2.9.1 Hose bibs shall be finished ¾" (20 mm) chrome plated brass, compression type with chrome plated handle and standard ¾" (20 mm) male hose connection or otherwise indicated on the Drawings.

2.10 Vacuum Breaker

2.10.1 Where indicated or otherwise required, vacuum breakers shall be installed and set at least

2.10.2 100 mm above the floor level of equipment or fixture rims to prevent contamination of water supply.

2.11 Shock Arrestor (Water Hammer)

2.11.1 Shock arrestor shall be mechanical pneumatic type, stainless steel construction with hermetically sealed bellows and threaded connection.

2.11.2 Arrestors shall be located adjacent to all quick closing valves, solenoid valves, where required and as indicated on Drawings.

2.11.3 Proper sizes shall be determined by the individual application.

2.12 Water Meter

2.12.1 Water meters, all bronze construction type, shall be supplied and installed by the Contractor. The water meter shall be a disk positive displacement type and shall be furnished with a straight reading dial and shall have a rated maximum delivery of not less than twice the flowing GPM (l/s).

2.13 Water Pressure Reducing Valves

2.13.1 Each valve shall be constructed of bronze body, with stainless steel spring and shaft and nylon diaphragm.

2.13.2 The spring shall be designed to provide the pressure reduction indicated on the Drawings.

2.13.3 The valve shall be designed for a work pressure of 250 psi and shall be threaded or flanged ended as the pipe connecting to it.

2.13.4 The valve shall be of the self contained type without any control lines with all internal parts being accessible by removing spring chamber and without dismantling the valve itself.

2.13.5 The valve shall be designed to operate smoothly and quietly without chattering or any water hammer problems.

2.14 Pipe Expansion Joints

2.14.1 Supply and install expansion joints wherever pipes cross structural expansion joints, wherever required to prevent undue stresses caused by thermal expansion of the pipes and wherever expansion cannot be accommodated by natural offsets and changes of direction.

2.14.2 Expansion joints shall be of the packless-bellow type with flanged or welded ends as suitable for the pipe application.

2.14.3 Bellows shall be of stainless steel and suitable for a pressure of 125 psi (860 Kpa) or the design working pressure, whichever is greater. Expansion joints shall be provided with guides to prevent any unnecessary misalignment of the pipe. Guides and anchor arrangements shall be per the recommendations of the expansion joints manufacturers and as shown on the drawings.

PART 3 EXECUTION

3.1 Arrangement and Alignment of Pipes

3.1.1 Install piping in a neat, workmanlike manner and the various lines shall be parallel to building walls wherever possible.

3.1.2 Install pipe groups for plumbing parallel with pipes of other trades.

3.1.3 Space pipe supports, arrange reducers and Pitch piping to allow air to be vented to system high points and to allow the system to be drained at the low paints. However, where obstructions exist, automatic air vents shall be installed at all air pocket points and ½" (15 mm) drain gate valves shall be supplied and installed at all low points and riser legs.

3.2 Special Requirement for PVC Pipe installation

3.2.1 Before installation, the pipe shall be inspected for defects. Defective, damaged or unsound pipe will be rejected. Deflections from a straight line or grade, between the center lines extended, of any 2 connecting pipes made necessary by vertical curves or horizontal curves or offsets, shall not exceed *12500/D* mm. per linear meter of pipe, where D represents the nominal internal diameter of the pipe expressed in millimeters. If the alignment requires deflections in excess of these limitations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set forth. Except where necessary in making connections with other lines, pipe shall be laid with the bells facing in the direction of laying.

3.2.2 Pipes in trenches-Place each length of pipe with a uniformly distributed bearing for the bottom 0.3 of the pipe on the sand fill in the trench. Excavate recesses to accommodate pipe bells, sleeves, glands or other fittings. Take up and re-Iay any pipe that has the grade or joint disturbed after laying. Clean the interior of the pipe of all foreign material before lowering into the trench, and keep clean during laying operations by means of plugs or other acceptable methods.

3.2.3 Plumbing vents exposed to sun light shall be protected by waterbase synthetic latex paints.

3.3 General Requirements for Piping Installation

3.3.1 Make all changes in size and direction of piping with standard fittings.

3.3.2 Make all branch connections with tees.

3.3.3 Use eccentric reducing fittings or eccentric reducing couplings where required by the contract documents or where required to prevent pocketing of liquid or non-condensable.

3.3.4 Pipe bending shall not be resorted to except in extreme cases and only after the written approval of the Engineer.

3.3.5 Piping shall be designed with Loops to take the thermal expansion. Wherever this is not possible for physical reasons, expansion joints with guides shall be used.

3.3.6 Installation of pipes shall be complete with all cutting, patching and making good of walls, slabs, partitions, etc., due to fixing, supporting and anchoring of pipes.

3.3.7 Automatic air vents shall be installed at all air pocket locations, and/or at the highest points in the lines.

3.3.8 Pipes and fittings shall both be manufactured according to one single standard unit of measurement either both English or both metric.

3.4 Connection to Equipment and Control Valves

3.4.1 Provide flanges or unions at all final connections to equipment and control valves to facilitate dismantling. Arrange connections so that the equipment being served may be removed without disturbing the piping.

3.4.2 Install all supply piping, pumps and other equiprnent including gate valves and strainers therein, at line size with the reduction in size being made only at the outlet piping from the control valve at the full size of the tapping in the equipment served.

3.5 Hangers, Supports, Anchors And Guides - General

3.5.1 Support, anchor and guide all piping to preclude failure or deformation. Construct and install hangers, supports, anchors, guides and accessories to the approval of the Engineer. Do not use wire, tape or metal bands. Supports shall be designed to support weight of pipe, weight of fluid and weight of pipe insulation.

3.5.2 Fasten piping securely to the structure without overstressing any portion of the supports or the structure itself. Secure pipe supports, anchors and guides to concrete by means of inserts or if greater load carrying capacity is required by means of steel fish plates embedded in the concrete.

3.5.3 Arrange hanger to prevent transmission of vibration from piping to building and supports.

3.5.4 Uninsulated copper or brass pipe and/or tubing shall be isolated from ferrous hangers or supports

3.5.5 Support piping and tubing at intervals indicated in the schedule hereinafter and at all changes in direction. Maximum deflection shall not exceed 3 mm.

3.5.6 Clearance for application of specified Vapor sealed insulation without cutting pipeline covering or fitting covering in installation of pipe hangers and fittings shall be provided.

3.5.7 Furnish pipe hangers and supports complete with rods, bolts, lock nuts, swivels, couplings, brackets and all other components and accessories, to allow installation to freely expand and contract.

3.5.8 Hangers shall be formed steel clevis type , unless otherwise specified, with adjustable attachment to hanger rod. For copper or brass pipe, use plastic sheathed hangers. Pipe hangers shall fit over vapor sealed insulated piping.

3.5.9 Where pipe exceeds maximum loading recommended for clevis type hanger, provide steel pipe clamps.

3.5.10 Provide trapeze hangers where several pipes can be installed parallel and at the same level. Trapeze shall be of steel channel sized to support load and drilled for rod hanger at each end. Provision should be made to keep the lines in their relative position to each other by the use of either clamps or clips.

3.5.11 Use roller supports, where provision for expansion is required. Rollers shall have cast iron adjustable bases.

3.5.12 For hanger rods on piping 3/8" (10 mm) thru 2" (50 mm) inclusive use 3/8" (10 mm) rods, and for piping 2 ½" (65 mm) thru 5" (125 mm) use 5/8" (16 mm) rods, and for piping 6"(150 mm) thru 12" (300 mm) use 7/8" (22 mm) rods.

3.5.13 Provide additional steel members required for hanging piping systems in areas with special conditions, or where vertical or horizontal structural steel supports are required other than those provided in the structure.

3.5.14 Provide lateral bracing for supporting rods over 4S0mm. long braced at every fourth hanger with diagonal bracing attached to slab or beam.

3.5.15 For floor supports, provide horizontal piping from floors with cast-iron rests, with pipe nipples to suit. Fasten to floor. Where provision for expansion is required, provide pipe roll stands, without vertical adjustment. Provide concrete or steel pipe piers, fasten stands to piers.

3.5.16 For wall supports, provide horizontal piping from wall with steel J-Hook for pipe located close to wall and not larger than 3" (80 mm) pipe. For greater loads, up to 1500 lbs (680 Kg) maximum loading provide welded steel bracket.

3.5.17 Pipe-covering (insulation) protection saddles.

3.5.18 Provide hanger shields to protect vapor sealed pipe insulation within mechanical equipment

rooms at each support point by a 360 degree insert of high density, 100 psi, waterproofed calcium silicate encased in a 120 ° sheet metal shield. Insert thickness shall be same as insulation. Shield length shall equal nominal pipe diameter, minimum but shall not be shorter than 100mm. and need not be longer than 300mm. if bearing load causes no discern able deformation. Insert shall extend 2Smm. beyond sheet metal shield.
100mm. shields shall be 26 gauge minimum. Shields 130 to 230mm. long shall be 20 gauge minimum. Shields longer than 230mm. shall be 16 gauge.

3.5.19 Provide penetration shields to encase insulated pipes penetrating fire walls or floors in a 360°, 24 gauge minimum sheet metal hanger shield with insert of high density, 100 psi. waterproofed calcium silicate the same thickness as insulation and further enclosed within the sleeve, sized for maximum 25mm. spacing between sleeve and insulation shield, pack annular space between sleeve and shield on both ends with double neoprene coated asbestos rope. Install an escutcheon plate to completely cover the wall penetration opening and fit snugly over the pipe insulation shield. Insert shall extend at least 25mm. beyond penetrated surface and escutcheon.

3.5.20 Provide oversize hangers with blocking the same thickness as the insulation to pitch vapor sealed insulated pipes accurately at time of insulation.

3.5.21 Maximum horizontal spacing for hangers are as follows:
:¾" and 1" (20 and 25 mm) steel pipe--2.5 meter
1 ¼"-2" (32 and 50 mm) steel pipe---3.0 meter
2 ½" -4" (65 and 100 mm)steel pipe ----4.0 meter
5"-6" (125 and 150 mm) steel pipe------5.0 meter B" (200 mm) and
above steel pipe ------6.0 meter Up to 1 ¼" (32 mm) copper pipe-----
2.0 meter
1 3/8" (40 mm) and over copper pipe--3.0 meter
2 ½" (65 mm) and smaller PVC pipe---l.2 meter
3" (80 mm) and over PVC pipe-----"1.8 meter
vertical spacing -PVC pipe-twice as those of hor. Spacing.
-other pipes - at every floor level.

3.5.22 Hangers on PVC pipes shall be of design which does not clamp the pipe tightly but permits axial movement.

3.5.23 Support but do not rigidly restrain PVC pipes at end of branches and at change of direction or elevation. Vertical piping shall be maintained in the straight alignment. Support trap arms in excess of 900mm in length as close as possible to the trap.

3.6 Pipe Sleeves

3.6.1 Provide all pipe openings through walls, partitions and slabs with sleeves having an internal diameter at least 50mm larger than the outside diameter of the pipe for un- insulated lines or of the insulation for insulated pipes.

3.6.2 Install sleeves through interior walls and partitions flush with finished surfaces; sleeves through outside walls to project 15mm. on each side of the finished waif; and floor sleeves to project 25mm. above finished floors.

3.6.3 Set sleeves in place before pouring concrete or securely fasten and grout in with cement.

3.6.4 Sleeve construction:

i. Interior Partitions - galvanized sheet iron.
ii. Interior & Exterior Masonry Walls and Floors-galvanized steel pipe.

3.6.5 Fill the space between outside of pipe or insulation and the inside of the sleeve or framed opening with fibrous asbestos in interior waifs and floors and pack with oakum, seal with watertight mastic or asphalt in exterior walls.

3.7 Cleaning of Piping Systems

3.7.1 Plug all opening ends of piping, valves and equipment except when actual work is being performed to minimize accumulation of dirt and debris.

3.7.2 After Installation is complete, place temporary screens at connections to all equipment and at automatic control valves where permanent strainers are not provided.

3.7.3 Prior to the performance of tests, flush out all piping that is to receive a hydrostatic test with clean water.

3.7.4 Remove dirt and debris collected at screens, strainers and other points from the system.

3.7.5 The Contractor shall disinfect water piping before it is placed in service. The Contractor shall furnish all equipment and materials necessary to do the work of disinfecting and shall perform the work in accordance with the procedure outlined in AWWA Standard for Disinfecting Water Mains Designation C 601-68. The dosage shall be such as to produce a chlorine residual for not less than 10 ppm after a contact period of not less than 24 hours. After treatment, the piping shall be flushed with clean water until the residual chlorine content does not exceed 0.2 ppm.

3.7.6 During the disinfecting period, care shall be exercised to prevent contamination of water in steel main.

3.8 PIPEWORK CLEARANCES AND SEGREGATION

3.8.1 Minimum clearance between uninsulated pipes, finished face of insulation on pipes and adjacent surfaces shall be as follows:

Walls	25	mm
Ceilings	100	mm
Finished Floors	100	mm
Adjacent pipes, both insulated	25	mm
Adjacent pipes, both uninsulated	25	mm
Insulated pipes adjacent to conduit trunking	100	mm
Uninsulated pipes adjacent to conduit trunking	150	mm
Uninsulated pipes adjacent to electrical cables not in conduit or trunking	150	mm
Insulated pipes adjacent to electrical cables not in conduit or trunking	100	mm

3.8.1 The spacing of services shall provide for the application of thermal insulation and valves and mange boxes and increased spacings to accommodate pipeline fittings.

3.8.2 The spacing of services shall provide for access to pipes and electrical services for ease of installation and maintenance.

3.8.3 The spacing shall be provided for cold water pipes to be away from hot pipes to minimize heat against.

3.9 Material Tests and Identification

3.9.1 In addition to the tests required for specific piping systems, the manufacturer shall test all materials as specified prior to delivery.

3.9.2 Check all materials for defects. Identify all materials with factory applied permanent stampings or markings designating their conformance to specified requirements.

3.10 Testing

3.10.1 <u>Water Pipes</u>

3.11.1 Test all domestic water ptpmq system, including valves, fittings and joints under a pressure equal to 100 psig (690 Kpa) or 1 % times the working pressure, whichever is greater.

3.11.2 Blank off or remove all elements such as traps, instruments, automatic valves, diaphragm valve, relief valves, pumps or any other equipment which may be damage by test pressure. Open, but do not back seat, all valves.

3.11.3 Fill the system with water and vent the system at high points to remove air. Maintain the required test pressure for sufficient length of time to enable complete inspection to be made of all joints and connections and for a minimum of six hours, unless specified otherwise.

3.11.4 Repair all leaks or defects uncovered by the tests and retest the system.

3.11.5 After test have been completed, drain the system and blowout and clean it of all dust and/or foreign matters. Clean all strainers, valves and fittings of all dirt, fillings and debris.

3.11 Installation of Unions and Flanges

3.11.1 Unions and flanges shall be installed at all equipment inlets and outlets, at all valves inlets or outlets, on all pipe branches and in general, every 15 metres of pipe run.

3.11.2 Unions shall be used on all screwed pipes and shall be of the same quality and service. Flanges, suitable for welding, shall be used on all welded pipes, and shall be all steel construction to ASTM or BS Standards.

3.11.3 Threaded flanges shall be used on all threaded pipes; when flanged valves and equipment are connected to the pipes, flanges shall be of the same quality and service as the pipe served, and shall conform to ASTM or BS Standards.

3.12 Approved List of Manufacturers

3.12.1 For acceptable Products, Manufacturers and Suppliers, refer to Appendix A.

End of Section 22 11 16.

SECTION 22 13 00

FACILITY SANITARY SEWAGE

SECTION 22 13 00
FACILITY SANITARY SEWAGE

PART 1 GENERAL

Works of this Section shall be governed by Conditions of Contract and it's requirements.

1.1 Sanitary Drainage

1.1.1 The Sanitary Drainage Systems consist of sanitary drainage, fixtures, fittings, piping and equipment as hereinafter specified and as shown on the Drawings. The sanitary drains shall be carried to appropriate manholes shown on the Drawings.

1.1.2 Pipe installations shall not be concealed within the building structure unUi satisfactory completion of the inspection and testing procedure.

1.1.3 Traps shall conform to BS 5572 and all relevant British Standards.

1.1.4 Plastic traps shall be to BS 3943 and of 'P' type unless otherwise specified.

1.1.5 For sinks, showers, baths, bidets and bowl urinals, traps shall be a two piece tubular trap, and bottle trap for lavatory basin.

1.1.6 Floor drains subject to evaporation shall have a water seal of 125mm.

1.1.7 All floor drains shall be set 3 mm. below the normal finished floor, with a gradual pitch extending away from the drain, unless otherwise noted on Architectural Drawings.

1.2 Site Drainage

1.2.1 The Site Drainage shall consist of site sanitary drainage complete with piping, manholes, submersible pumps, keep and all ancillaries as deemed necessary and as shown on the Drawings.

1.3 Reference Standard

1.3.1 All work under this section shall conform to the requirements of the National Plumbing Code Handbook and Uniform Plumbing Code, unless otherwise specified hereinafter.

1.4 Codes and Standards

1.4.1 Codes and standards applicable to this section shall be primarily British Standards and United States Codes, unless otherwise specified, the performance/manufacturing standards of items mentioned in this section shall confirm to the applicable portions of the latest editions of the following codes, standards and regulations.

Reference Code	Abbreviation	Applicable Standards	Title of Standards
National Plumbing Code	NPC		-
Uniform Plumbing Code	UPC		-
British Standards	BS	BS497	Specifications for manhole covers, road gully gratings and frames for drainage purposes
		BS4164	Specification for coaltar-based hot-applied coating materials for protecting iron and steel, including a suitable primer
		BS8005 PART 1	Guide to new sewerage construction.

1.5 Related Works Specified Elsewhere

1.5.1 The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated herein verbatim.

Section 22 05 00 - General Mechanical Requirements for Plumbing.
Section 22 07 00 - Plumbing Insulation
Section 22 12 00 - Facility Potable Water Storage Tanks
Section 22 14 00 - Facility Storm Drainage
Section 22 40 00 - Plumbing Fixtures
Section 22 90 00 - Pool and Fountain Plumbing System

PART 2 PRODUCTS

2.1 Gully Traps (PVC)

2.1.1 Each gully trap shall be of heavy duty UPVC construction and of the P or S-trap type.

2.1.2 Gully trap shall have either cast iron open grating cover or solid recessed cover with cast iron frame as shown on the Drawings and/or as need be.

2.2 PVC Floor Drains with Stainless Steel Cover

2.2.1 Supply and install wherever shown on the Drawings floor drains of sizes and shapes as indicated on the Drawings.

2.2.2 Each floor drain shall be of the UPVC construction with 70 mm water seal.

2.2.3 Drain shall have stainless steel AISI 304 removable square tile with circular grid strainer and stainless steel cover. The open area of the strainer shall be at least two-thirds of the cross-section area of the drain line to which it connects.

2.2.4 Stainless steel covers shall have minimum 15 years warranty.

2.2.5 Tile shall fit, as practical as possible, one floor tile of the space.

2.2.6 Drain shall be fitted with 1" (25mm) access plug for cleaning purposes.

2.2.7 This floor drain is applicable to bathrooms, toilets, kitchens and pantries.

2.2.8 Floor drain in Domestic Washing Machine Room shall be sealed type.

2.3 Flower Bed Drains

2.3.1 Each drain shall be of uPVC with trapped sump and flat type chrome plated brass or heavy duty stainless steel strainer.

2.3.2 Flower bed drains shall be supplied complete with stainless steel mesh enclosing the strainer and surrounded by gravels as detailed on drawings.

2.4 Cleanouts

2.4.1 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.

2.4.2 Floor pipe cleanouts on PVC pipes shall have stainless steel cover.

2.5 PVC Roof Vent Caps

2.5.1 Supp.ly and install vent caps on all vent stacks at the highest level of the stack and wherever shown on the Drawings.

2.5.2 Each vent cap shall be of UPVC with open slots all around cowl and shall be cemented onto the stack vent pipe at least 150 cm above roof level.

2.6 Trench Grate & Frame

2.6.1 Ductile or Cast Iron

2.6.1.1 Grate shall be ductile or cast iron, heavy rectangular, sectional bar pattern, suitable for heavy traffic. Grate openings shall be laid in wide dimensions in a steel frame with flat bar anchors and nailing clips.

2.6.2 Stainless Steel (For Kitchen Areas)

2.6.2.1 The grating should have an anti-slip surface. It should be manufactured from Grade 304 stainless steel. The frames shall be supplied ready for installation with all corners and angles already built-in. All frames shall have fixing ties to ensure a secure seating arrangement.

2.7 Frames, Covers & Gratings

2.7.1 All covers and frames shall be manufactured either from Cast iron to BS 497 Part I or Ductile iron manufactured to BSEN 124 as approved by Local Authority.

2.7.2 All castings for frames, covers, and gratings shall be made accurately to dimensions and shall be machined to provide even bearing surfaces. Covers and gratings must fit the frames in any position and if found to rattle under traffic, shall be replaced. Filling to obtain tight covers will not be permitted. No plugging, burning-in or filling will be allowed. All castings shall be carefully coated inside and out with epoxy coating complying with the requirements specified in BS 4164. Coating surfaces shall be clean, dry and free from rust before applying the coatings.

2.7.3 Covers of manholes located inside buildings shall be of double seal and those located outside shall be of single seal.

2.7.4 Covers of last manhole discharging to city sewer shall be integral with GRP sealing plate.

2.8 Bronze Floor Drains

2.8.1 Supply and install bronze floor drain in all mechanical rooms in hospital building and service building of sizes and shaped as indicated on the drawings.

2.8.2 Drain shall have Tundish (Funnel) to receive waste water from indirect waste lines and exposed grate surrounding Tundish to receive drain from surrounding floor area.

2.8.3 Each floor drain shall consist of cast bronze body, flashing collar with seepage opening and polished bronze adjustable strainer head with Tundish attached to the grate with concealed screws, permitting funnel to be moved to different positions on the grate. Tundish diameter shall be 100 mm.

2.9 PVC Floor Drains

2.9.1 Supply and install wherever shown on the Drawings floor drains of sizes and shapes as indicated on the Drawings.

2.9.2 Each floor drain shall be of the UPVC construction with 70 mm water seal.

2.9.3 Drain shall have white polypropylene removable square tile with circular grid strainer. The open area of the strainer shall be at least two-thirds of the cross section area of the drain line to which it connects.

2.9.4 Drain shall be fitted with 1" (25mm) access plug for cleaning purposes.

2.9.5 This drain shall be applicable to shafts.

2.10 PVC Floor Drains with Sealed Type Stainless Steel Cover

2.10.1 Supply and install whenever down on the drawings floor drains of sizes and shapes or indicated on the drawings.

2.10.2 Each floor drain shall be of the UPVC construction with 70 mm water seal.

2.10.3 Drain shall have stainless steel AISI 304 removable square tile with stainless steel screw type circular access cover or with gasket and stainless steel screws.

2.10.4 Stainless steel covers shall have minimum 15 years warranty.

2.10.5 Drain shall be fitted with 1" (25 mm) access plug for cleaning purposes.

2.10.6 This floor drain is applicable for washing machine outlets.

2.11 Floor Drains

2.11.1 Supply and install where shown on drawings extra-heavy duty floor drains of sizes as indicated thereupon.

2.11.2 Each drain shall have square or round top, dura-coated cast iron body with p-trap and brass screwed access cap, cast iron raising piece (if need be), heavy duty grating and suspended sediment bucket.

PART 3 EXECUTION

3.1 Internal Drainage Installation Requirements

3.1.1 All horizontal soil and waste piping shall be installed with a slope of not less than one percent (1%) unless otherwise specified and/or noted on the Drawings.

3.1.2 All horizontal soil and waste piping shall be installed with a slope of not less than one percent (1%) unless otherwise specified and/or noted on the Drawings.

3.1.3 All plumbing fixtures shall be individually trapped and vented. Rough in and install fixtures at height as recommended by manufacturer unless otherwise indicated. Sinks directly connected to grease traps shall not be trapped.

3.1.4 Vent piping shall not be trapped and shall be graded to drip back to waste or soil line.

3.1.5 Changes in direction of piping shall be generally made with long radius fittings.

3.1.6 Floor drains subject to evaporation shall have a water seal of 125mm.

3.1.7 Floor drains shall be clamped to flashing or to water proofing membrane. Clamping collars shall be supplied with drains only where flashing is required.

3.1.8 All floor drains shall be set 3 mm. below the normal finished floor, with a gradual pitch extending away from the drain, unless otherwise noted on Architectural Drawings.

3.1.9 All pipes and fittings shall be kept clean, with the exposed ends of in-completed or unconnected work to be plugged.

3.1.10 Cleanouts shall be placed at all changes in directions, at bends, at ends of soil, waste, sewer and as shown on drawings with a maximum spacing of 15 m. on straight runs inside building.

3.1.11 All pipes running under building or under streets shall be encased in concrete of minimum100 mm thickness.

3.1.12 All work done under this section shall be in accordance with the National Plumbing Code Handbook and Uniform Plumbing Code unless otherwise specified.

3.2 External. Drainage Installation Requirements

3.2.1 Connections to manholes shall be watertight after installation.

3.2.2 All piping shall conform accurately to the lines and grades shown on the Drawings.

3.2.3 Any connections for existing systems shall be made with a minimum amount of disturbance to the existing lines.

3.2.4 Any existing pipe lines or structures which are damaged while making connections shall be replaced or reconstructed to the satisfaction of the Engineer without cost to the Employer.

3.2.5 All piping shall be examined for defects. Any defective piece discovered after installation and test shall be removed and replaced by the Contractor at no expense to the Employer.

3.2.6 System shall be inspected and joints approved before any backfilling is placed over pipes.

3.2.7 All pipe and fittings shall be kept clean until final acceptance of work. The exposed ends of all in-completed lines shall be closed with wooden plugs adequately secured at all times when pipe laying is not actually in progress.

3.2.8 All piping shall be installed on a good foundation and adequate means taken to prevent settlement.

3.2.9 Precautions shall be taken to protect incomplete work from flooding due to storms or other causes. All pipe lines or structures not stable against uplift during construction shall be thoroughly braced or otherwise protected.

3.3 Manholes Installation Requirements

3.3.1 Manholes shall have the minimum inside dimensions shown on the Drawings.

3.3.2 Manhole walls shall be of poured-in-place reinforced concrete. Top section must be cast such as to suit elevation and accommodate size of manhole frame and cover.

3.3.3 Manhole floor shall be of reinforced concrete and inverts stream lined with cement and mortar into a semi-circular path with sanitary turns and have their corners filled and sloped towards the water path to prevent any settlements of solids as detailed on the Drawings.

3.3.4 Concrete foundation matts for manholes shall be constructed in accordance with details as shown on the Drawings.

3.3.5 All pipes or castings to be embedded in the manhole walls shall be accurately set, and if so required, headers shall be laid round the casting so embedded.

3.3.6 All work must be carried out in a manner to ensure watertight work, and any leaks shall be caulked, repaired, or the entire work shall be removed and rebuilt. Attention is particularly called to the necessity of keeping the water level below all parts of the foundation and walls until the cement has obtained adequate setting.

3.4 Trench Bottom Grading

3.4.1 All Trench Bottom Grading Required For Plumbing Work Shall Be Done Under The Requirements Of This Section Of The Specification. The Bottom Of All Trenches Shall Be Trimmed By Hand Method To Receive Pipes At Their Respective Finish Levels. Trenches Shall Not Be Excavated By Machine Below Levels As Above Specified.

3.4.2 After The Pipe Lines Have Been Tested And Approved, Backfill Shall Be Compacted Thoroughly By Hand Tampers Below Center Lines Of Pipes And To At Least 300mm Above It. No Backfill Shall Be Placed In Such A Manner As To Cause Damage Or Misalignment To The Pipes Or Protective Coating If Used. Backfill Material Under Such Conditions Shall Be Earth, 20mm Crushed Stone Or Gravel Above The Top Of Piping And Hubs.

3.5 Frames, Covers & Gratings

3.5.1 The Contractor shall furnish and set level and to the proper grade, frame and cover or frame and grating of the form and dimensions shown on the Drawings. The concrete masonry shall be neatly and accurately brought to the dimensions of the base of the frame. The frames shall be thoroughly embedded in mortar. All covers and frames shall be to BS 497 Part 1.

3.5.2 All castings for frames, covers, and gratings shall be of tough gray iron, complying with BS 2789: 1973 (Updated 1985). All castings shall be made accurately to dimensions and shall be machined to provide even bearing surfaces. Covers and gratings must fit the frames in any position and if found to rattle under traffic, shall be replaced. Filling to obtain tight covers will not be permitted. No plugging, burning-in or filling will be allowed. All castings shall be carefully coated inside and out with coal tar based material complying with the requirements specified in BS 4164. Coating surfaces shall be clean, dry and free from rust before applying the coatings.

3.5.3 Covers of manholes located inside buildings shall be of double seal and those located outside shall be of single seal.

3.6 Excavation and Backfilling for Pipe Laying

3.6.1 The laying of pipe underground will require trimming and grading of trench bottoms for pipes and will require backfilling with approved materials and tamping around all pipes to center line of pipes as the pipe laying progresses to provide protection and stability for the piping. Pipe laying work shall be conducted so that trenching operations are not advanced too far ahead of pipe laying operations resulting in excessive lengths of open trenches.

3.6.2 The pipe shall not be laid in water or when the trench or weather conditions are unsuitable for such work.

3.6.3 The Contractor shall trim the bottom of all trenches to receive pipes and shall provide grade finish by hand methods. The bottoms of all trenches shall be rounded so that, in so far as practical at least one-third of the circumference of the pipe will rest firmly on 200 mm. of undisturbed sand at proper line and grade. Bell holes, where required, shall be dug to ensure pipe resting for its entire length upon the bottom of the trench. Trenches shall not be excavated below grade by machine.

3.6.4 After pipes have been tested and approved, trenches shall be backfilled with approved materials carefully deposited in layers not to exceed 150 mm. in thickness on both sides, and thoroughly and carefully tamped. Backfilling and tamping in layers of 150 mm. shall be continued until a depth of 300 mm. has been placed over the pipe. Backfill around the pipes to a depth of 150 mm. shall be clean sand. No backfill shall be placed in a manner such as to cause injury to the pipe. Where pipe crossings occur, the lower pipe shall be laid first and the backfill thoroughly compacted to the level of laying the higher pipe. Backfill materials under such conditions shall be earth, approved gravel or concrete as directed.

3.6.5 Care should be taken to provide adequate cover before using power compactors or heavy rollers.

3.6.6 All pipes running under roads and all pipes with a cover of less than one meter, should be protected by laying concrete or precast concrete slab over the bedding.

3.7 Drainage Testing

3.7.1 If an inspection of the completed sewer or any part thereof shows any structures, pipes or joints which are defective, the defective work shall be replaced or repaired immediately and to the satisfaction of the Engineer.

3.7.2 The Contractor shall perform, at his own expense, any tests or inspections required by local authorities. The Engineer shall witness the tests.

3.7.3 All joints shall be inspected and an inspection of the line as a whole shall show pipes to be true to line and grade with full circles visible at all manholes.

3.8 Fixtures Testing

3.8.1 When the roughing-in work is completed and before connection of fixtures, the entire system shall be subjected to thorough flushing and then to a water test by plugging up all openings and filling all of the lines as per tests sections. Any defects shall be corrected, at the expense of the Contractor.

3.8.2 After all fixtures are connected, the entire system shall be subjected to a smoke test. For PVC piping the correct grade of cartridge should be selected so that it is not harmful to the pipe-work or joint materials or an air test shall be performed in accordance with BS B005 Part 1.

3.8.3 Tests shall be performed in the presence of the parties having jurisdiction and the Engineer, and all results shall be recorded.

3.9 Approved List of Manufacturers:

3.9.1 For accepted products, Manufacturers and suppliers, refer to Appendix A.

End of Section 22 13 00.

SECTION 22 13 16
SANITARY WASTE AND VENT PIPING

SECTION 22 13 16

SANITARY WASTE AND VENT PIPING

PART 1 GENERAL

Works of this Section shall be governed by Conditions of Contract and it's requirements.

1.1 Introduction

1.1.1 Works of this Section shall be governed by Conditions of Contract and requirements.

1.1.2 This section describes basic materials and requirements for Pipework services installations for building.

1.2 Related Works Specified Elsewhere

1.2.1 The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated herein verbatim.

Section 22 0500 - General Mechanical Requirements for Plumbing.
Section 22 0700 - Plumbing Insulation
Section 22 13 00 - Facility Sanitary Sewerage
Section 22 14 00 - Facility Storm Drainage
Section 22 40 00 - Plumbing Fixtures

1.3 Storage of UPVC Pipes

1.3.1 UPVC pipe and fittings shall be stored under cover at all times. Sun light shall not be permitted to come into contact with the PVC materials at any time, except during installation in trench. The pipes shall be stored on flat level ground free from large or sharp edged stones or objects, and shall be stacked to a maximum height of 1.5 m. (or as recommended by the manufacturer) with sockets at alternate ends, and in such a manner as to prevent sagging or bending.

1.4 Pipe Identification

1.4.1 All pipes shall be indelibly marked at intervals of not greater than 3m. The marking shall show the manufacturer's identification, the standard name and number, and the nominal size and class. Adhesive labels alone shall not suffice. All pipes complying with British Standards shall be kite marked.

1.5 Codes and Standards

1.5.1 Codes and standards applicable to this section shall be primarily British Standards and United States Codes, unless otherwise specified, the performance manufacturing standards of items mentioned in this section shall confirm to the applicable portions of the latest editions of the following codes, standards and regulations.

Reference Code	Abbreviation	Applicable Standard	Title of Standard
American Water Works Association	AWWA	C601-68 C501-67 M45	FIBERGLASS PIPE DESIGN MANUAL
American Society for Testing and Materials	ASTM	ASTM A53-88a	Specification for pipes, steel, black and Hot-Dipped, Zinc-Coated, Welded and Seamless

		ASTM A307	Specification for Carbon Steel Bolts and Studs. 60,000 psi tensile Strength
		ASTM D1785	Specification for poly (vinyl chloride) (PVC) plastic pipe schedules 40, 80, and 120.
		ASTM D3517M	Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermo-Setting-Resin) Pressure Pipe.
American Standards Association	ASA	ASA 40.1	-
		ASA B16.22	-
		ASA B1618	-
		ASA B9.1	-
		ASA B35.5	-
British Standards	BS	BS 4514	Specification for unplasticized PVC soil and venting pipes, fittings and accessories.
		BS 5255	Specification for thermoplastics waste pipe and fittings.
		BS 5254	Specification for polypropylene waste pipe and fittings (external diameter 34.6 rnm, 41.0 mm and 54.1 mm)
		BS 3505	Specification for unplasticized polyvinyl chloride (PVC-U) pressure pipes for cold potable water
		BS 4346 Part 1	Joints and fittings for use with unplasticized PVC pressure pipes. Injection moulded un plasticized PVC fittings for solvent welding for use with pressure pipes, including potable water supply.
		BS4346 Part 2	Mechanic joints and fittings, principally of unplasticized PVC.
		BS 4660	Specification for unplasticized polyvinyl chloride (PVC-U) pipes and plastics fittings of nominal sizes 110 and 160 for below ground gravity, drainage, and Sewerage
		BS 5480	Specification for Glass Reinforced Plastic (GRP) Pipes, Joints and Fittings for use of Water Supply or Sewerage.

		BS 5481	Specification for unplasticized PVC pipe and fittings for gravity sewers
		BS 1387	Specification for screwed and socketed steel tubes and tubular and for plain and steel tube suitable for welding or for screwing to BS21 p
		BS 3601	Specification for carbon steel pipes and tubes with specified room temperature properties for pressure pipes.
		BS 21	Specification for pipe threads for tubes and fittings where pressure light joints are made on the threads.
Deutches Institute for Normung	DIN	DIN 19534	-
American National Standards Institute	ANSI	ANSI B18.2.2	
		ANSI B31.1	
		ANSI A21, 10, 11	-

PART 2 PRODUCTS

2.1 UPVC Pipes TYPE 1

2.1.1 Polyvinyl chloride pipes (PVC) shall be of the unplasticized rigid type and of high density and complete homogeneity material

2.1.2 UPVC Pipes - Type 1 shall comply with BS EN 1329-1 : 2000 specification for pipes, fittings and the system.

2.1.3 UPVC Pipes - Type 1 piping systems shall be used in the field of:

2.1.3.1 Soil and waste discharge systems (low and high temperature) inside buildings (marked with "B").

2.1.3.2 Soil and waste discharge systems for both inside buildings and buried in ground within the building structure (marked with "BD").

2.1.3.3 Ventilation pipe work.

2.1.4 UPVC Pipes Type 1 piping system sockets and spigots shall be either tor solvent cement joints or ring seal joints.

2.2 UPVC Pipes - Type 3

2.2.1 Polyvinyl chloride pipes (PVC) shall be of the un-plasticized rigid type and of high density and complete homogeneity material.

2.2.2 UPVC Pipes - Type 3 shall comply with BS EN 1401-1 : 1998 specifications for pipes, fittings and the system.

2.2.3 UPVC Pipes - Type 3 shall be used in the field of non-pressure under ground drainage and sewerage:

2.2.3.1 Outside the building structure (marked "U") and

2.2.3.2 Both buried in ground within the building structure and outside the building (marked "0").

2.3 High Density Polyethylene Pipes (HDPE)

2.3.1 HDPE pipes shall be made from polyethylene (PE) as per ISO 4427: 1996 (E) Standard.

2.3.2 HDPE pipes shall be manufactured from polyethylene type PE 100 resin, it shall contain only those antioxidants, UV stabilizers and pigments necessary for the manufacture of pipes confirming to ISO 4427 specifications.

2.3.3 Pressure rating for HDPE pipes shall be SDR 11 (pn 16), nominal outside diameter and the wall thickness shall conform to ISO 161-1:1996.

2.3.4 Fittings shall be electrofusion type for pipe upto 4" (100 mm) dia. and butt fusion for pipes above 4" (100 mm) dia.

2.3.5 HDPE pipes shall be allowed to be used for drainage pipes buried in raft.

2.4 Piping Schedule

2.4.1 General

2.4.1.1 Piping classes are specified for each service in the following schedule. The designations indicated refer to detailed specifications for piping in this section of the specifications:

2.4.2 Piping Classes

Service	Piping Class
Drainage and vent pipes above ground	PVC Type 1
Sanitary sewer under building structure	PVC Type 3
Sanitary sewer running in raft slab	HDPE

PART 3 EXECUTION

3.1 Arrangement and Alignment of Pipes

3.1.1 Install piping in a neat, workmanlike manner and the various lines shall be parallel to building walls wherever possible.

3.1.2 Install pipe groups for plumbing parallel with pipes of other trades.

3.1.3 Space pipe supports, arrange reducers and Pitch piping to allow air to be vented to system high points and to allow the system to be drained at the low points. However, where obstructions exist, automatic air vents shall be installed at all air pocket points and ½" (15 mm) drain gate valves shall be supplied and installed at all low points and riser legs.

3.2 **Special Requirement for PVC Pipe Installation**

3.2.1 Before installation, the pipe shall be inspected for defects. Defective, damaged or unsound pipe will be rejected. Deflections from a straight line or grade, between the center lines extended, of any 2 connecting pipes made necessary by vertical curves or horizontal curves or offsets, shall not exceed 12500/D mm. per linear meter of pipe, where D represents the nominal internal diameter of the pipe expressed in millimeters. If the alignment requires deflections in excess of these limitations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set forth. Except where necessary in making connections with other lines, pipe shall be laid with the bells facing in the direction of laying.

3.2.2 Pipes in trenches-Place each length of pipe with a uniformly distributed bearing for the bottom 0.3 of the pipe on the sand fill in the trench. Excavate recesses to accommodate pipe bells, sleeves, glands or other fittings. Take up and relay any pipe that has the grade or joint disturbed after laying. Clean the interior of the pipe of all foreign material before lowering into the trench, and keep clean during laying operations by means of plugs or other acceptable methods.

3.2.3 Plumbing vents exposed to sun light shall be protected by waterbase synthetic latex paints.

3.2.4 Thermal Expansions

3.2.4.1 When drainage and vent stacks exceed six (6) meters in height, approved expansion joints, restraint fittings and offsets shall be placed on vertical risers and horizontal branches as follows:

3.2.5 Expansion joints are recommended at alternate floors in all vertical stacks.

3.2.6 Expansion joints shall be placed in horizontal branches containing two or more vertical risers and exceeding ten (10) meters in length immediately upstream of vertical riser whenever possible.

3.2.7 .An expansion joint, shall be placed below the connection point of a waste pipe to the stack, if this connection is exposed below floor slab, and above the connection point if this connection is above floor slab.

3.2.8 No expansion joints shall be required in building drain below grade.

3.2.9 Approved expansion fittings that utilize rubber-o-rings in a recessed groove may be used to compensate for thermal expansion. The ring slides along the pipe when expansion or contraction occurs. Expansion joints shall be installed by solvent cementing techniques.

3.3 General Requirements for Piping Installation

3.3.1 Make all changes in size and direction of piping with standard fittings.

3.3.2 Make all branch connections with tees.

3.3.3 Use eccentric reducing fittings or eccentric reducing couplings where required by the contract documents or where required to prevent pocketing of liquid or non-condensable.

3.3.4 Pipe bending shall not be resorted to except in extreme cases and only after the written approval of the Engineer.

3.3.5 Piping shall be designed with Loops to take the thermal expansion. Wherever this is not possible for physical reasons, expansion joints with guides shall be used.

3.3.6 Installation of pipes shall be complete with all cutting, patching and making good of walls, slabs, partitions, etc., due to fixing, supporting and anchoring of pipes.

3.3.7 Pipes and fittings shall both be manufactured according to one single standard unit of measurement in metric.

3.4 Pipe Sleeves

3.4.1 Provide all pipe openings through walls, partitions and slabs with sleeves having an internal diameter at least 50mm larger than the outside diameter of the pipe for un- insulated lines or of the insulation for insulated pipes.

3.4.2 Install sleeves through interior walls and partitions flush with finished surfaces; sleeves through outside walls to project 15mm.. on each side of the finished wall; and floor sleeves to project 25mm. above finished floors.

3.4.3 Set sleeves in place before pouring concrete or securely fasten and grout in with cement.

3.4.4 Sleeve construction:

- Interior Partitions - galvanized sheet iron.
- Interior & Exterior Masonry Walls and Floors-galvanized steel pipe.

3.4.5 Fill the space between outside of pipe or insulation and the inside of the sleeve or framed opening with fibrous asbestos in interior walls and floors and pack with oakum, seal with watertight mastic or asphalt in exterior walls.

3.5 Cleaning of Piping Systems

3.5.1 Plug all opening ends of piping, valves and equipment except when actual work is being performed to minimize accumulation of dirt and debris.

3.5.2 After installation is complete, place temporary screens at connections to all equipment and at automatic control valves where permanent strainers are not provided.

3.5.3 Prior to the performance of tests, flush out all piping that is to receive a hydrostatic test with clean water.

3.5.4 Remove dirt and debris collected at screens, strainers and other points from the system.

3.5.5 The Contractor shall disinfect water piping before it is placed in service. The Contractor shall furnish all equipment and materials necessary to do the work of disinfecting and shall perform the work in accordance with the procedure outlined in AWWA Standard for Disinfecting Water Mains Designation C 601-68. The dosage shall be such as to produce a chlorine residual for not less than 10 ppm after a contact period of not less than 24 hours. After treatment, the piping shall be flushed with clean water until the residual chlorine content does not exceed 0.2 ppm.

3.5.6 During the disinfecting period, care shall be exercised to prevent contamination of water in steel main.

3.6 Material Tests and Identification

3.6.1 In addition to the tests required for specific piping systems, the manufacturer shall test all materials as specified prior to delivery.

3.6.2 Check all materials for defects. Identify all materials with factory applied permanent stampings or markings designating their conformance to specified requirements.

3.7 Testing

3.7.1 <u>Drainage and Sewer Pipes</u>

3.7.1.1 Drains and sewers should generally be subjected to an internal pressure test of 1.2 m head of water above the crown of the pipe at the high end but not more than 6 m at the low end Inspection and tests should be made during the installation and as the work proceeds, to ensure the pipework is properly secured and clear of obstructing debris and superfluous matter.

3.7.1.2 The final test of the completed drainage and vent system shall be made by filling all traps with water and then introducing into the entire system a pungent, thick smoke produced by one or more smoke machines. When the smoke appears at stack openings on the roof, the stack openings shall be closed and a pressure equivalent to a 1-inch water column (248.8 Pa) shall be held for a test period of not less than 15 minutes.

3.8 Approved List of Manufacturers:

3.8.1 For accepted products, Manufacturers and suppliers, refer to Appendix A.

<u>End of Section 22 13 16.</u>

SECTION 22 40 00

SANITARY FIXTURES

SECTION 22 40 00

SANITARY FIXTURES

PART 1 GENERAL

Works of this Section shall be governed by Conditions of Contract and it's requirements.

1.1 Scope of Work

1.1.1 The Sanitary Fixtures along with accessories, pipe fittings shall be installed and put in operation as hereinafter specified and as shown on drawings.

1.1.2 All fixtures and trimmings, insofar as practicable, shall be of one manufacture.

1.1.3 Ample application of petroleum jelly shall be made to all surfaces of exposed chrome plated piping, valves and fittings immediately after installation.

1.1.4 All fixtures shall be set straight and true.

1.1.5 Concealed brackets, hangers and plates shall have a shop coat of paint.

1.1.6 All exposed piping and trim shall be chrome plated and fully protected during installation. Strap or padded wrenches shall be used on chrome plated pipe fittings and valves.

1.1.7 Contractor shall comply with authorities requirements for Green Building (if applicable) and shall consider the following flow rates:-

1.1.7.1 Maximum flow rate for shower = 1.5 gpm
1.1.7.2 Maximum flow rate for Lavatory = 0.5 gpm
1.1.7.3 Maximum flow rate for all toilets = 1.1 gallon per flush
1.1.7.4 All Toilets shall be dual flush.
1.1.7.5 All ablutions taps shall be self closing type.

1.2 Related Works Specified Elsewhere

1.2.1 The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated herein verbatim.

Section 22 05 00 - General Mechanical Requirements for Plumbing
Section 22 10 00 - Plumbing Piping and Pumps
Section 22 30 00 - Plumbing Equipment

PART 2 PRODUCTS

2.1 Sanitary Fixtures

2.1.1 Sanitary fixtures shall be complete with all required trimming, including mixers, waste plugs, traps, supplies, stop valves, escutcheons, casings and all necessary hangers, plates, brackets, anchors and supports.

2.1.2 Vitreous china fixtures shall be of first quality with smooth glazed surfaces, free from warp, cracks, checks, discolorations or other imperfections.

2.1.3 Enameled cast iron fixtures shall be of acid-resisting type.

2.1.4 In the selection of sanitary fixtures and their accessories, model numbers of certain manufacturers catalogues are given to describe the type, shape and quality of the items requested and do not in any way limit the supply to the model listed. Any item of different make judged by the Engineer to be similar in quality and manufacture will be approved.

2.1.5 All fixtures and fittings types and models shall be as detailed in the schedule of fixtures, indicated on the Drawings.

2.2 Accessories

2.2.1 Accessories shall be provided in the locations indicated on Architectural Drawings and fixed at heights indicated therein or as directed by the Engineer. The Accessories shall be from approved manufacturers.

PART 3 EXECUTION

3.1 Exposed Piping and Trim in Toilet Areas

3.1.1 All piping, valves and fittings exposed to view shall be screwed, polished, chrome plated brass. Plating shall be accomplished after threading.

3.2 Fixture Setting

3.2.1 Fixtures shall be set in a neat, finished and uniform manner making the connections to all fixtures at right angles to the wall, unless otherwise directed by the Engineer. Roughing for this work must be accurately laid out so as to conform to finished wall material. Fixtures are not to be set until so directed by the Engineer.

3.2.2 The location and disposition of all items shall be as indicated on the relevant drawings.

3.3 Cleaning

3.3.1 On a daily basis as the Works of this Section proceed, remove and dispose of all debris resulting from the Works of this Section.

3.3.2 Leave work areas of the Works of this Section broom clean at the end of each work day.

3.4 Approved List of Manufacturers

3.4.1 For acceptable Products, Manufacturers and Suppliers, refer to Appendix A.

End of Section 22 40 00

SECTION 230500

COMMON WORK RESULTS FOR HVAC

SECTION 23 05 00
COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.1 General Requirements

1.1.1 The work of this Section shall be governed by General Conditions of Contract.

1.1.2 It is the Contractors responsibility to be fully aware of and comply with all of the requirements of the above listed documents, and further assure that all Subcontractors are equally informed.

1.1.3 It is the Contractor's responsibility to be fully aware of and comply with all of the requirements of the district cooling provider in case the project is served by district cooling system.

1.2 Application

1.2.1 This section applies to and is part of all Sections of Division 23.

1.3 Scope of Works

1.3.1 The works covered under this contract include supply, installation, testing, adjusting and putting into operation systems, components of systems, and individual items of equipment, and work related thereto, in accordance with the project Tender Documents. Products not mentioned but obviously necessary for the completion of those works shall be provided such as, but are not limited to the following:

- Requirements of fire dampers wherever duct crossing fire wall.
- System air balancing and associated requirements to do the balancing
- Maintaining the noise levels as specified
- Steel platforms (fly over) above services in plant rooms and roof.
- Chemical dosing and flushing of chilled water system to the satisfaction of the Engineer.

1.3.2 Unless specifically mentioned otherwise, the following electrical works and materials for the Mechanical equipment shall be supplied and installed under Division 23 of the specification but in all respect to the requirements of the Electrical Specifications.

a- All control panels including door lock disconnected switches, push buttons, starters, contractors, circuit breakers, time delays, selector switches, relays, transformers, timers, controllers, pilot lights, set points, alarms and all other electrical equipment which are necessary for the satisfactory operation, control and protection of all plant supplied under this section of the specifications.

b- Whenever a number of starters controllers, instruments, indicating lights and the like occur or are shown on the Mechanical and/or electrical Drawings, they shall be arranged in a central position in a neat, easily cleaned, factory-built panel, or motor control center assembly. The assembly shall include isolators and all necessary fuses, busbars, starters, instruments, relays, push-buttons, indicating lights and the like. Components shall be mounted in a logical order based on the sequence of operation.

c- All control equipment including thermostats, sensors, detectors, actuators, controllers, pressure level and flow switches, annunciation alarms, remote control stations and all such equipment needed for the proper system operation.

d- All control wiring for the above mentioned equipment.

e- Final connection, between disconnect switches, power outlets, flex outlet and mechanical equipment.

f- The following electrical works and materials for the mechanical equipment shall be supplied and installed under the electrical part of this contract.

i. All power supply up to and including the following:

· Power outlets for fan coil units.
· Disconnect switches when specified to be installed separate from the control panel.
· Flex outlet for exhaust fans.

ii. Power supply up to control panels when specified with an integral disconnect switch
iii. Power supply to disconnect switches when the switches are built-in the equipment.
iv. Empty conduits with pull wires for all cables and wires classified under the mechanical scope of works.

v. Control outlet boxes for all control equipment classified under the mechanical scope of works.

vi. Power cables and conduits or fixing arrangement between chilled water pumps, air handling units, etc .. and their control panel.

vii. Power cables and conduits from central control panel to the various equipment controlled from the same panel, such as exhaust fans, supply air fans, etc ..

1.4 Quality Assurance

1.4.1 the manufacturer's of all materials and equipment must have at least ten years of experience in the design and manufacture of their products.

1.5 Related Work Specified Elsewhere

1.5.1 In addition to the mentioned above, the works shown herein after shall be applicable along with the requirements of the related divisions and sections.

1.6 Engineer's Drawings

1.6.1 The Drawings are based on design and include general layouts and typical details of various systems to be installed. The Contractor shall make the installations in a workmanlike manner to conform to the structure, to avoid obstructions, to preserve head room, and to keep openings and passage ways clear without additional instruction and without additional cost to the owner.

1.7 Shop Drawings and Data to be submitted for Approval

1.7.1 The Contractor shall submit Shop Drawings showing the exact routing and locations of all the piping, ducting, equipment, etc., all in their respective locations and according to the dimensions of the approved manufacturer. Shop Drawings scale shall be *1/10, 1/20, 1/50* and *1/100* as applicable and as approved by the Engineer.

1.7.2 The Contractor shall submit catalog cuts and brochures of products with reference to proper paragraph in specifications. All submittals shall be binded in one Booklet.

1.7.3 The Contractor shall submit adequate Engineering data on each piece of equipment together with all characteristic curves, capacity selection charts and all data for testing and balancing of the systems. In addition the Contractor shall submit manufacturer's printed installation instructions.

1.7.4 The Contractor shall submit at the beginning of the project a schedule of submittals for materials and shop drawings to the approval of the Engineer.

1.8 Approved Materials

1.8.1 All materials shall be furnished in accordance with the requirements of the Specifications. The naming of manufacturers in the Specifications shall be strictly adhered to in all circumstances.

1.8.2 Substitution of materials other than those named shall not be submitted.

1.8.3 Materials shall be delivered in unbroken packages bearing the brand and maker's name, and shall be stored on platforms and properly covered to protect them from moisture, heat and dust.

1.8.4 All materials shall be supplied from the main factories in the country of origin of the manufacturer. Any deviation from this, like supplying equipment assembled in another different country under a license or another name is not accepted unless approved by the Engineer.

1.9 Instruction Period

1.9.1 The Contractor shall be responsible for the training and familiarization of the Employer's maintenance staff for a period of at least six weeks on all equipment and plants he has supplied or installed.

1.10 Machinery Guards

1.10.1 All moving parts of machinery shall be protected by strong guards to adequately protect all personnel working on or in the vicinity of equipment.

1.10.2 Wherever possible, moving parts should be protected by guards supplied by the equipment manufacturer. All guards must be strongly attached to equipment and should be designed to be easily removed for access, servicing, adjustment and maintenance.

1.11 Instruction Manual and As-built Drawings

1.11.1 The Contractor shall furnish and submit to the Engineer in electronic and hard copy triplicate bound, A4 size, Instruction Manuals containing the following material:

1.11.2 Brief description of each system and its service and basic operation features.

1.11.3 Manufacturer's mechanical equipment parts list of all functional components of the systems listed on the Drawings, control diagrams and wiring diagrams of controllers. List shall give system No., unit no., Manufacturer's Model No., and Manufacture's Drawing no. Parts list shall include manufacturer's recommended spare parts for one year operation.

1.11.4 Chart of the tag numbers, location and function of each valve.

1.11.5 Maintenance instructions for each type of equipment.

1.11.6 Possible breakdowns and repairs for each type of equipment.

1.11.7 List of nearest local suppliers for all equipment.

1.11.8 Manufacturer's literature describing each piece of equipment control diagrams and wiring diagrams of controllers.

1.11.9 Complete, as installed, color coded wiing diagrams of all electrical motor controller connections and interlock connections of other mechanical equipment.

1.11.10 The Contractor shall furnish all the foregoing to the Engineer for his review as to the fulfillment of the specified requirements.

1.11.11 All items shall be available at least four weeks prior to the substantial completion date.

1.12 Abbreviations

1.12.1 The following abbreviations have been mentioned in the specifications.

1.12.1.1 AMCA - Air Moving and Conditioning Associations.
1.12.1.2 ANSI - American National Standard Institute.
1.12.1.3 ARI - Air Conditioning and Refrigeration Institute.

1.12.1.4	ASA	- Acoustical Society of America, American Standards Association.
1.12.1.5	ASHRAE	- American Society of Heating Refrigeration and Air Conditioning Engineers
1.12.1.6	ASME	- American Society of Mechanical Engineers.
1.12.1.7	ASTM	- American Society for Testing and Materials.
1.12.1.8	BSI	- British Standards Institution
1.12.1.9	SMACNA	- Sheet Metal and Air Conditioning Contractors National Association
1.12.1.10	UL	- Under Writers Laboratories.
1.12.1.11	BTU	- British Thermal Units.

1.13 Workmanship

1.13.1 All workmanship required to accomplish the work mentioned in Mechanical specification or shown on related Drawings, shall conform to the highest standards, and as required by the Engineer.

1.13.2 The Engineer will be the sale judge of the standards required.

PART 2 EXECUTION

2.1 Cleaning and Adjusting

2.1.1 All apparatus shall be thoroughly cleaned before being placed in operation. Finished surfaces shall be restored if damaged and entire installation shall be delivered in perfect condition, subject to the approval of the Engineer. Systems shall be adjusted and balanced to operate as shown in the Drawings and herein specified.

2.2 Tests

2.2.1 All piping and equipment shall be tested as specified under the corresponding section of the Specifications and to meet local and specified requirements ...Provide anemometers, thermometers, gauges, voltmeters, ammeters, and similar instruments, not part of the permanent installation, but required to record the performance of the equipment and systems. Labor, materials, power, etc..., required for testing, shall be furnished by the Contractor, unless otherwise indicated under the particular section of the Specifications.

2.2.2 Tests shall be performed in the presence of representatives of the Engineer and such other parties that have legal jurisdiction and all results shall be recorded.

2.2.3 In general, pressure tests shall be applied to piping systems only before connection of fixtures, equipment and appliances. In no case shall any piping, fixtures, equipment or appliances be subjected to pressures exceeding the ratings as prescribed by the manufacturers of fixtures, equipment and appliances, or accepted engineering standards for piping and fittings.

2.2.4 All defective work shall be promptly repaired or replaced and the tests shall be repeated until the particular system and component parts thereof receive the approval of the Engineer and authorities having jurisdiction, and at no additional cost to the Employer.

2.2.5 Any damages resulting from tests shall be repaired and/or damaged materials replaced, all to the satisfaction of the Engineer, and at no additional cost to the Employer.

2.2.6 The duration of tests shall be as determined by all parties having jurisdiction, but in no case less than the time prescribed in each division of the Specifications.

2.2.7 The following tests should be furnished for but limited to the following:

a- Vibration isolation test
b- Sound attenuator test
c- Insulation test
d- Chilled water pipe tests
e- Chiller Test
f- Refrigeration plant test.
g- Pump tests

h- Air handling unit tests
i- Fan coil unit tests
j- Air and water balancing
k- Exhaust systems tests
l- Noise and vibration measurement
m- Room condition tests
n- Controls and building management test

2.3 Coordination of Trades

2.3.1 The Contractor shall coordinate the work to ensure orderly, timely installations of the work of applicable trades within the various spaces indicated.

2.4 Access Doors

2.4.1 Access doors shall provide ready access to concealed control valves, traps, cleanouts, motors, fire dampers, and other items requiring operation, adjustment, or maintenance.

2.4.2 Doors and frames shall be of 12-gauge galvanized steel with invisible hinges, and cam lock fastenings. For plaster walls or ceiling, frames shall have a 50 mm. wide lath plaster bond. For masonry walls, the frame shall be set flush with masonry with provisions in the jamb for anchoring. Doors shall be solid flush steel with grey metal primer. Location of access doors shall be coordinated with and shall have the approval of the Engineer before the mechanical work is installed.

2.5 Permits

2.5.1 The Contractor shall obtain and pay for all necessary permits, inspections and tests, for the proper installation of his work, as may be required by the various administrative authorities having jurisdiction.

2.5.2 Certificates of inspections, tests etc., with the proper approval certified thereon, shall be secured by the Contractor and these documents shall be delivered to the Engineer before the work in question will be accepted.

2.6 Openings in Exterior Walls

2.6.1 Openings in exterior walls, particularly at or below grade shall be kept properly plugged and caulked at all times, (except when being worked on) to preclude the possibility of flooding due to storms or other causes. After completion of work, openings shall be permanently sealed and caulked in the manner herein specified.

End of Section 23 05 00.

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING

PART 1 GENERAL

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING

PART 1 GENERAL

Works of this Section shall be governed by Conditions of Contract.

1.1 Hangers and Supports, Anchors and Guides - General

1.1.1 Support, anchor and guide all piping to preclude failure or deformation. Construct and install hangers, supports, anchors, guides and accessories to the approval of the Engineer. Do not use wire, tape or metal bands. Supports shall be designed to support weight of pipe, weight of fluid and weight of pipe insulation.

1.1.2 Fasten piping securely to the structure without overstressing any portion of the supports or the structure itself. Secure pipe supports, anchors and guides to concrete by means of inserts or if greater load carrying capacity is required by means of steel fishplates embedded in the concrete.

1.1.3 Arrange hanger to prevent transmission of vibration from piping to building and supports.

1.1.4 Un-insulated copper or brass pipe and/or tubing shall be isolated from ferrous hangers or supports

1.1.5 Support piping and tubing at intervals indicated in the schedule hereinafter and at all changes in direction. Maximum deflection shall not exceed 3 mm.

1.1.6 Clearance for application of specified Vapour sealed insulation without cutting pipeline covering or fitting covering in installation of pipe hangers and fittings shall be provided.

1.1.7 Furnish pipe hangers and supports complete with rods, bolts, lock nuts, swivels, couplings, brackets and all other components and accessories, to allow installation to freely expand and contract.

1.1.8 Hangers shall be formed steel clevis type, unless otherwise specified, with adjustable attachment to hanger rod. For copper or brass pipe, use plastic sheathed hangers. Pipe hangers shall fit over vapour sealed insulated piping.

1.1.9 Where pipe exceeds maximum loading recommended for clevis type hanger, provide steel pipe clamps.

1.1.10 Provide trapeze hangers where several pipes can be installed parallel and at the same level. Trapeze shall be of steel channel sized to support load and drilled for rod hanger at each end. Provision should be made to keep the lines in their relative position to each other by the use of either clamps or clips.

1.1.11 For hanger rods on piping 3/8" (10 mm) thru 2" (50 mm) inclusive use 3/8" (10 mm) rods, and for piping 2 ½" (65 mm) thru 5" (125 mm) use 5/8" (16 mm) rods, and for piping 6"(150 mm) thru 12" (300 mm) use 7/8" (22 mm) rods.

1.1.12 Provide additional steel members required for hanging piping systems in areas with special conditions, or where vertical or horizontal structural steel supports are required other than those provided in the structure.

1.1.13 Provide lateral bracing for supporting rods over 450mm. long braced at every fourth hanger with diagonal bracing attached to slab or beam.

1.1.14 Floor supports - provide for supporting horizontal piping from floors with cast-iron rests, with pipe nipples to suit. Fasten to floor. Where provision for expansion is required, provide pipe roll stands, without vertical adjustment. Provide concrete or steel pipe piers, fasten stands to piers.

1.1.15 Wall supports - provide for supporting horizontal piping from wall with steel J-Hook for pipe located close to wall and not larger than 3" (80 mm) pipe. For greater loads, up to 1500 Ibs (680 Kg) maximum loading provide welded steel bracket.

1.1.16 Pipe-covering (insulation) protection saddles.

1.1.17 Provide hanger shields to protect vapor sealed pipe insulation within mechanical equipment rooms at each support point by a 360 degree insert of high density, 100 psi, waterproofed calcium silicate encased in a 120 o sheet metal shield. Insert thickness shall be same as insulation. Shield length shall equal nominal pipe diameter, minimum but shall not be shorter than 100mm. and need not be longer than 300mm. if bearing load causes no discernable deformation. Insert shall extend 25mm. beyond sheet metal shield. 100mm. shields shall be 26 gauge minimum. Shields 130 to 230mm. long shall be 20 gauge minimum. Shields longer than 230mm. shall be 16 gauge.

1.1.18 Provide penetration shields to encase insulated pipes penetrating fire walls or floors in a 360° 24 gauge minimum sheet metal hanger shield with insert of high density, 100 psi. waterproofed calcium silicate the same thickness as insulation and further enclosed within the sleeve, sized for maximum 25mm. spacing between sleeve and insulation shield, pack annular space between sleeve and shield on both ends with double neoprene coated asbestos rope. Install an escutcheon plate to completely cover the wall penetration opening and fit snugly over the pipe insulation shield. Insert shall extend at least 25mm. beyond penetrated surface and escutcheon.

1.1.19 Provide oversize hangers with blocking the same thickness as the insulation to pitch vapor sealed insulated pipes accurately at time of insulation.

1.2 Horizontal Piping Support Schedule

1.2.1 Steel, Copper and PVC Pipes

- ¾" and 1" (20 and 25 mm) steel pipe-----2.5 meter
- 1 ½"-2" (32 and 50 mm) steel pipe-------3.0 meter
- 2 ½"-4" (65 and 100 mm)steel pipe ------4.0 meter
- 5"-6" (125 and 150 mm) steel pipe---------5.0 meter
- 8" (200 mm) and above steel pipe ---------6.0 meter
- Up to 1 ½" (32 mm) copper pipe----------2 ..0 meter
- 1 ¼" (40 mm) and over copper pipe------3.0 meter
- 2 ½" (65 mm) and smaller PVC pipe-------1.2 meter
- 3" (80 mm) and over PVC pipe-------------1.8 meter

1.3 Approved List of Manufacturers:

1.3.1 For accepted products, Manufacturers and suppliers, refer to Appendix A.

End of Section 23 05 29.

SECTION 230593

TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 General

1.1 Related Documents

1.1.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division D1 Specification Sections, apply to this Section.

1.2 Summary

1.2.1 A qualified and approved third party shall carry out and certify the commissioning, testing, adjusting and balancing of the installed systems as per the relevant commissioning code of the British Chartered Institute of Building Services (CIBS) or ASHRAE Standards.

1.2.2 Major equipment such as chillers, cooling towers, fresh air units, chilled water pumps and heat exchangers shall be tested and commissioned at factory and contractor shall arrange for the Client Representative and consultant to witness this test at factory.

1.2.3 Testing, adjusting and balancing for all the installed systems shall include chilled water distribution, air distribution, noise and vibration measurement, automatic controls as per the procedure herein after.

1.2.4 The Contractor shall be responsible to provide during installation all necessary provisions to carry out the above works as required by the third party.

1.2.5 All costs shall be paid by the Contractor.

1.3 General Requirements

1.3.1 All piping and equipment shall be tested as specified under the relevant subsection of the specification.

1.3.2 Labour, materials, instruments, power etc., required for testing shall be furnished by the contractor unless otherwise indicated under the particular section of the Specification

1.3.3 Test shall be performed in the presence of representatives of the Engineer and such other parties as may have legal jurisdiction.

1.3.4 In general, pressure tests shall be applied to piping system only, before connection of fixtures, equipment and appliances. In no case shall any piping, fixtures, equipment or appliances be subjected to pressure exceeding the ratings as prescribed by the manufacturers of fixtures, equipment and appliances or accepted engineering standards for piping and fittings.

1.3.5 All defective work shall be promptly repaired or replaced and the tests shall be repeated until the particular system and component parts thereof receive the approval of the Engineer and authorities having jurisdiction, and at no additional cost to the Employer.

1.3.6 Any damages resulting from tests shall be repaired and/or damaged materials replaced, all to the satisfaction of the Engineer, and at no

1.3.7 The duration of tests shall be as determined by all parties having jurisdiction, but in no case less than the time prescribed in each subsection of the specification

1.3.8 In the event of any repair or any adjustment having to be made other than normal running adjustment, the test shall be void and shall be repeated after the adjustment or repairs have been made.

1.3.9 When pipes, valves, equipment etc., are to be covered or embedded or insulated; their specific tests shall be carried out on them before any covering is applied. These tests shall not relieve the contractor of any of his responsibilities and he shall take all necessary precautions to insure the safety and protection of such tested items until the termination of the work.

1.3.10 Three copies of all test results shall be submitted to the Engineer.

1.4 Submittals

1.4.1 Two copies of Testing, Adjusting and Air Balancing strategies plans to be submitted. Plans should show step-by-step procedures as specified in Part 3. Include also a complete set of report forms intended for use on this Project.

1.4.2 Submit two copies of reports prepared, as specified in this Section, on approved forms certified by Testing, Adjusting and Air Balancing firm. Warranties if specified in this Section.

1.5 Quality Assurance

1.5.1 Ensure the participation of Testing, Adjusting and Air Balancing team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide notice in advance of scheduled meeting time and location.

1.5.2 Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist Testing, Adjusting and Air Balancing activities.

1.5.3 Certify Testing, Adjusting and Air Balancing field data reports by reviewing field data reports to validate accuracy of data, and certify that Testing, Adjusting and Air Balancing team complied with approved Testing, Adjusting and Air Balancing plan and the procedures specified and referenced in this Specification.

1.5.4 Use approved standard forms.

1.5.5 Calibrate instruments at least every six months or more frequently as required by instrument manufacturer.

1.5.1.1 Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.6 Project Conditions

1.7.1 Completed areas of the project might be occupied during Testing, Adjusting and Balancing or before Substantial Completion. Cooperate with Owner during Testing, Adjusting and Balancing operations to minimize conflicts with Client's operations.

1.7 Warranty

1.7.2 Provide a guarantee on National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that-

1.7.3 The certified Testing, Adjusting and Balancing firm has tested and balanced systems according to the Contract Documents.

1.7.4 Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 PRODUCTS

NOT APPLICABLE

PART 3 EXECUTION

3.1 Examination

3.1.1 Examine the Contract Documents to become familiar with Project requirements and to address conditions in systems' designs that may preclude proper Testing, Adjusting and Balancing of systems and equipment.

3.1.1.1 Contract Documents are defined in the General and Supplementary Conditions of Contract.

3.1.1.2 Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

3.1.2 Examine approved submittal data of HVAC systems and equipment.

3.1.3 Examine Project Record Documents described in Division 01 Section "Project Record Documents."

3.1.4 Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

3.1.5 Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

3.1.6 Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

3.1.7 Examine system and equipment test reports.

3.1.8 Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

3.1.9 Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

3.1.10 Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

3.1.11 Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

3.1.12 Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

3.1.13 Examine strainers for clean screens and proper perforations.

3.1.14 Examine heat-transfer coils for correct piping connections and for clean and straight fins.

3.1.15 Examine system pumps to ensure absence of entrained air in the suction piping.

3.1.16 Examine equipment for installation and for properly operating safety interlocks and controls.

3.1.17 Examine automatic temperature system components to verify the following:

3.1.17.1 Dampers, valves, and other controlled devices are operated by the intended controller.

3.1.17.2 Dampers and valves are in the position indicated by the controller.

3.1.17.3 Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air -volume terminals.

3.1.17.4 Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.

3.1.17.5 Thermostats and humidistats are located without adverse effects of sunlight, drafts, and cold walls.

3.1.17.6 Sensors are located to sense only the intended conditions.

3.1.17.7 Sequence of operation for control modes is according to the Contract Documents.

3.1.17.8 Controller set points are set at indicated values.

3.1.17.9 Interlocked systems are operating.

3.1.18 Report deficiencies discovered before and during performance of Testing, Adjusting and Balancing procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 Preparation

3.2.1 Prepare a Testing, Adjusting and Balancing plan that includes strategies and step-by-step procedures.

3.2.2 Complete system readiness checks and prepare system readiness reports. Verify the following :

3.2.2.1 Permanent electrical power wiring is complete. Hydronic

3.2.2.2 systems are filled, clean, and free of air. Automatic

3.2.2.3 temperature-control systems are operational. Equipment

3.2.2.4 and duct access doors are securely closed. Balance,

3.2.2.5 smoke, and fire dampers are open.

3.2.2.6 Isolating and balancing valves are open and control valves are operational.

3.2.2.7 Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.

3.2.2.8 Windows and doors can be closed so indicated conditions for system operations can be met

3.3 Testing and Balancing Producers

3.3.1 Testing Air Balancing General Procedure

3.3.1.1 Perform testing and balancing procedures on each system according to the procedures shown herein after.

3.3.1.2 Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

3.3.1.3 Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan- speed control levers, and similar controls and devices, to show final settings.

3.3.1.4 Take and report testing and balancing measurements in inch-pound (IP) and metric (SI) units

3.3.1.5 Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

3.3.1.6 Prepare schematic diagrams of systems' "as-built" duct layouts.

3.3.1.7 Develop a plan to simulate diversity for variable-air-volume systems.

3.3.1.8 Determine the best locations in main and branch ducts for accurate duct airflow measurements.

3.3.1.9 Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

3.3.1.10 Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

3.3.1.11 Verify that motor starters are equipped with properly sized thermal protection.

3.3.1.12 Check dampers for proper position to achieve desired airflow path.

3.3.1.13 Check for airflow blockages.

3.3.1.14 Check condensate drains for proper connections and functioning.

3.3.1.15 Check for proper sealing of air-handling unit components.

3.3.1.16 Check for proper sealing of air duct system.

3.3.1.17 A complete set of special tools, oil and grease for all the plant and equipment supplied, adequate for 12 months operation shall be supplied by the Contractor at the completion date of the project.

3.3.2 Procedures for Constant-Volume Air Systems

3.3.2.1 Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

3.3.2.1.1 Measure fan static pressures to determine actual static pressure as follows:-

a.]Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.

b. Measure static pressure directly at the fan outlet or through the flexible connection.

c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.

d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3.3.2.1.2 Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3.3.2.1.3 Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.

3.3.2.1.4 Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.

3.3.2.1.5 Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.

3.3.2.1.6 Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motoramperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.

3.3.2.2 Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

3.3.2.2.1 Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

3.3.2.2.2 Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

3.3.2.3 Measure terminal outlets and inlets without making adjustments.

3.3.2.3.1 Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

3.3.2.4 3.3 .2.4 Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values .. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.

3.3.2.4.1 Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.

3.3.2.4.2 Adjust patterns of adjustable outlets for proper distribution without drafts.

3.3.3 <u>Procedures for Variable-Air-Volume Systems</u>

3.3.3.1 Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

3.3.3.2 Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

3.3.3.2.1 Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.

3.3.3.2.2 Select the terminal unit that is most critical to the supply-fan airflow and static pressure.

3.3.3.2.3 Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.

3.3.3.2.4 Measure total system airflow. Adjust to within indicated airflow.

3.3.3.2.5 Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.

3.3.3.2.6 Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

3.3.3.2.7 Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

3.3.3.2.8 Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.

3.3.3.2.9 Record the final fan performance data.

3.3.3.3 Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

3.3.3.3.1 Balance systems similar to constant-volume air systems.

3.3.3.3.2 Set terminal units and supply fan at full-airflow condition.

3.3.3.3.3 Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.

3.3.3.3.4 Readjust fan airflow for final maximum readings.

3.3.3.3.5 Measure operating static pressure at the sensor that controls the supply fan, if one is installed, and verify operation of the static-pressure controller.

3.3.3.3.6 Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.

3.3.3.3.7 Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.

3.3.3.3.8 Measure the return airflow to the fan while operati.ng at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

3.3.3.4 Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

3.3.3.4.1 Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

3.3.3.4.2 Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.

3.3.3.4.3 Set terminal units at full-airflow condition.

3.3.3.4.4 Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.

3.3.3.4.5 Adjust terminal units for minimum airflow.

3.3.3.4.6 Measure static pressure at the sensor.

3.3.3.4.7 Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

3.3.4 <u>Procedures for Motors</u>

3.3.4.1 Motors, *1/2* HP and Larger: Test at final balanced conditions and record the following data:

3.3.4.1.1 Manufacturer, model, and serial numbers.

3.3.4.1.2 Motor horsepower rating.

3.3.4.1.3 Motor rpm.

3.3.4.1.4 Efficiency rating.

3.3.4.1.5 Nameplate and measured voltage, each phase.

3.3.4.1.6 Nameplate and measured amperage, each phase.

3.3.4.1.7 Starter thermal-protection-element rating.

3.3.4.2 Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.3.5 Procedures For Condensing Units

3.3.5.1 Verify proper rotation of fans.

3.3.5.2 Measure entering- and leaving-air temperatures.

3.3.5.3 Record compressor data.

3.3.6 Procedures for Temperature Measurements

3.3.6.1 During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

3.3.6.2 Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

3.3.6.3 Measure outside-air, wet- and dry-bulb temperatures.

3.3.7 Procedures for Space Pressurization Measurements and Adjustments

3.3.7.1 Before testing for space pressurization, observe the space to verify the integrity of the space boundaries. Verify that windows and doors are closed and applicable safing, gaskets, and sealants are installed. Report deficiencies and postpone testing until after the reported deficiencies are corrected.

3.3.7.2 Measure, adjust, and record the pressurization of each room, each zone, and each building by adjusting the supply, return, and exhaust airflows to achieve the indicated conditions.

3.3.7.3 Measure space pressure differential where pressure is used as the design criteria, and measure airflow differential where differential airflow is used as the design criteria for space pressurization.

3.3.7.3.1 For pressure measurements, measure and record the pressure difference between the intended spaces at the door with all doors in the space closed. Record the high-pressure side, low-pressure side, and pressure difference between each adjacent space.

3.3.7.3.2 For applications with cascading levels of space pressurization, begin in the most critical space and work to the least critical space.

3.3.7.3.3 Test room pressurization first, then zones, and finish with building pressurization.

3.3.7.4 To achieve indicated pressurization, set the supply airflow to the indicated conditions and adjust the exhaust and return airflow to achieve the indicated pressure or airflow difference.

3.3.7.5 For spaces with pressurization being monitored and controlled automatically, observe and adjust the controls to achieve the desired set point.

3.3.7.5.1 Compare the values of the measurements taken to the measured values of the control system instruments and report findings.

3.3.7.5.2 Check the repeatability of the controls by successive tests designed to temporarily alter the ability to achieve space pressurization. Test over-pressurization and under pressurization, and observe and report on the system's ability to revert to the set point.

3.3.7.5.3 For spaces served by variable-air-volume supply and exhaust systems, measure space pressurization at indicated airflow and minimum airflow conditions.

3.3.7.6 In spaces that employ multiple modes of operation, such as normal mode and emergency mode or occupied mode and unoccupied mode, measure, adjust, and record data for each operating mode.

3.3.7.7 Record indicated conditions and corresponding initial and final measurements. Report deficiencies.

3.3.8 Procedures for Vibration Measurements

3.3.8.1 Use a vibration meter meeting the following criteria:

3.3.8.1.1 Solid-state circuitry with a piezoelectric accelerometer.
3.3.8.1.2 Velocity range of 0.1 to 10 inches per second (2.5 to 254 *mm/s).* Displacement range of 1 to 100 mils (0.0254 to 2.54 mm). Frequency range of at least 0 to 1000 Hz.
3.3.8.1.3 Capable of filtering unwanted frequencies.
3.3.8.2 Calibrate the vibration meter before each day of testing.

3.3.8.2.1 Use a calibrator provided with the vibration meter.
3.3.8.2.2 Follow vibration meter and calibrator manufacturer's calibration procedures.

3.3.8.3 Perform vibration measurements when other building and outdoor vibration sources are at a minimum level and will not influence measurements of equipment being tested.

3.3.8.3.1 Turn off equipment in the building that might interfere with testing.
3.3.8.3.2 Clear the space of people.

3.3.8.4 Perform vibration measurements after air and water balancing and equipment testing is complete.

3.3.8.5 Clean equipment surfaces in contact with the vibration transducer.

3.3.8.6 Position the vibration transducer according to manufacturer's written instructions and to avoid interference with the operation of the equipment being tested.
3.3.8.7 Measure and record vibration on rotating equipment over 3 hp (2.2 kW).

3.3.8.8 Measure and record equipment vibration, bearing vibration, equipment base vibration, and building structure vibration. Record velocity and displacement readings in the horizontal, vertical, and axial planes.

3.3.8.8.1 Fans and HVAC Equipment with Fans:

a. Fan Bearing: Drive end and opposite end.
b. Motor Bearing: Drive end and opposite end.
c. Equipment Casing: Top and side.
d. Equipment Base: Top and side.
e. Building Floor.
f. Ductwork: To and from equipment after flexible connections.
g. Piping: To and from equipment after flexible connections.

3.3.8.8.2 HVAC Equipment with Compressors:

a. Compressor Bearing: Drive end and opposite end.
b. Motor Bearing: Drive end and opposite end.
c. Equipment Casing: Top and side.
d. Equipment Base: Top and side.
e. Building: Floor.
f. Piping: To and from equipment after flexible connections

3.3.8.9 For equipment with vibration isolation, take floor measurements with the vibration isolation blocked solid to the floor and with the vibration isolation floating. Calculate and report the differences.

3.3.8.10 Inspect, measure, and record vibration isolation.

3.3.8.10.1 Verify that vibration isolation is installed in the required locations.

3.3.8.10.2 Verify that installation is level and plumb.

3.3.8.10.3 Verify that isolators are properly anchored.

3.3.8.10.4 For spring isolators, measure the compressed spring height, the spring OD, and the travel to-solid distance.

3.3.8.10.5 Measure the operating clearance between each inertia base and the floor or concrete base below. Verify that there is unobstructed clearance between the bottom of the inertia base and the floor.

3.3.9 Procedures for Sound-Level Measurements

3.3.9.1 Perform sound-pressure-Ievel measurements with an octave-band analyzer complying with ANSI S1.4 for Type 1 sound-level meters and ANSI S1.11 for octave-band filters. Comply with requirements in ANSI S1.13, unless otherwise indicated.

3.3.9.2 Calibrate sound meters before each day of testing. Use a calibrator provided with the sound meter complying with ANSI S1.40 and that has NIST certification.

3.3.9.3 Use a microphone that is suitable for the type of sound levels measured. For areas where air velocities exceed 100 fpm (0.51 *m/s),* use a windscreen on the microphone.

3.3.9.4 Perform sound-level testing after air and water balancing and equipment testing are complete.

3.3.9.5 Close windows and doors to the space.

3.3.9.6 Perform measurements when the space is not occupied and when the occupant noise level from other spaces in the building and outside are at a minimum.

3.3.9.7 Clear the space of temporary sound sources so unrelated disturbances will not be measured. Position testing personnel during measurements to achieve a direct line-of-sight between the sound source and the sound-level meter.

3.3.9.8 Take sound measurements at a height approximately 48 inches (1200 mm) above the floor and at least 36 inches (900 mm) from a wall, column, and other large surface capable of altering the measurements.

3.3.9.9 Take sound measurements in dBA and in each of the 8 unweighted octave bands in the frequency range of 63 to 8000 Hz.

3.3.9.10 Take sound measurements with the HVAC systems off to establish the background sound levels and take sound measurements with the HVAC systems operating.

3.3.9.10.1 Calculate the difference between measurements. Apply a correction factor depending on the difference and adjust measurements.

3.3.10 Procedures for Stair-Case Pressurization System Measurements and Adjustments

3.3.10.1 Before testing, observe the stair tower to verify that construction is complete. Verify the following:

3.3.10.1.1 Walls and ceiling are free of unintended openings and are capable of achieving a pressure boundary.

3.3.10.1.2 Fire stopping and sealants are installed.

3.3.10.1.3 Doors, door closers, and door gaskets are installed and adjusted.

3.3.10.1.4 If applicable, window installation is complete.

3.3.10.2 Measure and record wind speed and direction, outside-air temperature, and relative humidity on each test day.

3.3.10.3 Test each stair tower as a single system. If multiple fans serve a single stair tower, operate the fans together.

3.3.10.4 Air Balance:

3.3. 10.4.1 Open the doors indicated to be open and measure, adjust, and record the airflow of each:

a. Stair-tower fan.
b. Air outlet supplying the stair tower.

3.3. 10.4.2 For ducted systems, measure the fan airflow by duct Pitot-tube traverse.

3.3.10.5 Pressurization Test

3.3.10.5.1 After air balancing is complete, perform stair-tower pressurization tests.

3.3.10.5.2 Establish a consistent procedure for recording data throughout the entire test. Set the stair-tower side of the doors as the reference point and the floor side of the doors with positive pressure when higher than the stair tower, and negative pressure when lower than the stair tower.

3.3.10.5.3 With the HVAC systems operating in their normal mode of operation and the stair-tower pressurization systems off, measure and record the following:

a. Pressure difference across each stair-tower door with all doors in the stairwell closed.

b. Force necessary to open each door, using a spring-type scale.

3.3.10.5.4 With the HVAC systems operating and the stair-tower pressurization system activated, perform the following:

a. Place building HVAC systems in their normal operating mode .including equipment not used to implement smoke control, such as air-handling units, toilet exhaust fans, fan coil units, and similar equipment.

b. Measure and record the pressure difference across each stair-tower door with all doors in the stair tower closed. Adjust the stair-tower pressure relief to prevent over pressurization.

c. Use a spring scale to measure and record the force needed to open the door closest to the fan. With the initial door held in the open position, measure and record the pressure difference across each remaining closed stair-tower door.

d. Open additional doors (up to the number indicated) one at a time, and measure and record the pressure difference across each remaining closed stair-tower door after the opening of each additional door.

e. Open the doors indicated to be open and measure and record the direction and velocity through each of the open doors by a traverse of every 1 sq. ft. (0.093-sq. m) grid of door opening.

f. Calculate the average of the door velocity measurements. Compare the average velocity to the Contract Documents and governing code requirements.

3.3.10.5.5 Repeat the pressurization tests with the smoke-control systems and the HVAC systems operating.

3.3.10.5.6 Criteria for Acceptance:

a. The opening force on any door shall not exceed 30 Ibf (133 N).
b. Code requirements.

3.3.10.6 Operational Tests:

3.3.10.6.1 Check the proper activation of the stair-tower pressurization system(s) in response to all means of activation, both automatic and manual.

3.3.10.6.2 Verify that each initiating occurrence produces the proper system response under each of the following modes of operation:

a. Normal.
b. Alarm.
c. Manual override of normal mode and alarm.
d. Return to normal.

3.3.10.6.3 Verify that the smoke detector at the stair pressurization fan inlet de-energizes the fan and closes the damper at the fan.

3.3.10.6.4 If standby power is provided for stair pressurization systems, test to verify that the stair pressurization systems operate while on both normal and standby power.

3.3.10.6.5 Conduct additional tests required by authorities having jurisdiction.

3.3.10.7 Prepare a complete report of observations, measurements, and deficiencies.

3.3.11 <u>Procedures for Smoke-Control System Testing</u>

3.3.11.1 Before testing smoke-control systems, verify that construction is complete and verify the integrity of each smoke-control zone boundary. Verify that windows and doors are closed and that applicable safing, gasket, and sealants are installed. Report deficiencies and postpone testing until after the reported deficiencies are corrected.

3.3.11.2 Measure and record wind speed and direction, outside-air temperature, and relative humidity on each test day.

3.3.11.3 Measure, adjust, and record airflow of each smoke-control system with all fans that are a part of the system operating as intended by the design.

3.3.11.4 Measure, adjust, and record the airflow of each fan. For ducted systems, measure the fan airflow by duct Pitot-tube traverse.

3.3.11.5 After air balancing is complete, perform the following pressurization testing for each smoke control zone in the system:

3.3.11.5.1 Verify the boundaries of each smoke-control zone.

3.3.11.5.2 With the HVAC systems in their normal mode of operation and smoke control not operating, measure and record the pressure difference across each smoke-control zone. Make measurements after closing doors that separate the zones. Make one measurement across each door. Clearly indicate the high and low pressure side of each door.

3.3.11.5.3 With the system operating in the smoke-control mode and with each zone in the smoke control system activated, perform the following:

a. Measure and record the pressure difference across each door that separates the smoke zone from adjacent zones. Make measurements with doors that separate the smoke zone from the other zones closed. Clearly indicate the high and low pressure side of the door. Doors that have a tendency to open slightly due to the pressure difference should have one pressure measurement made while held closed and another measurement made with the door open.

b. Continue to activate each separate zoned smoke-control system and make pressure difference measurements.

c. After testing a smoke zone's smoke-control system, deactivate the HVAC systems involved and return them to their normal operating mode before activating another zone's smoke-control system.

d. Verify that controls necessary to prevent excessive pressure differences are functional.

3.3.11.6 Operational Tests:

3.3.11.6.1 Check the proper activation of each zoned smoke-control system in response to all means of activation, both automatic and manual.

3.3.11.6.2 Check automatic activation in response to fire alarm signals received from the building's fire alarm and detection system. Initiate a separate alarm for each means of activation to ensure that the proper operation of the correct zoned smoke-control system occurs.

3.3.11.6.3 Check and record the proper operation of fans, dampers, and related equipment as outlined below for each separate zone of the smoke-control system.

a. Fire zone in which a smoke-control system automatically activates.

b. Type of signal that activates a smoke-control system, such as pull station, sprinkler water flow, or smoke detector.

c. Smoke zone(s) where maximum mechanical exhaust to the outside is implemented and no supply air is provided.

d. Positive pressure smoke-control zone(s) where maximum air supply is implemented and no exhaust to the outside is provided.

e. Fan(s) "ON" as required to implement the smoke-control system. Multiple- or variable-speed fans should be further noted as "MAX. VOLUME" to verify that the intended control configuration is achieved.

f. Fan(s) "OFF" as required to implement the smoke-control system.
g. Damper(s) "OPEN" where maximum airflow must be achieved.
h. Damper(s) "CLOSED" where no airflow should take place.

i. Auxiliary functions to achieve the smoke-control system configuration such as changes or override of normal operating pressure and temperature-control set points.

j. If standby power is provided for the smoke-control system, test to verify that the system functions while operating under both normal and standby power.

3.3.11.7 Conduct additional tests required by authorities having jurisdiction. Unless required by authorities having jurisdiction, perform testing without the use of smoke or products that simulate smoke.

3.3.11.8 Prepare a complete report of observations, measurements, and deficiencies.

3.3.12 Procedures for Indoor-Air Quality Measurements

3.3.12.1 After air balancing is complete and with HVAC systems operating at indicated conditions, perform indoor-air quality testing.

3.3.12.2 Observe and record the following conditions for each HVAC system:

3.3.12.2.1 3.3.12.2.1 The distance between the outside-air intake and the closest exhaust fan discharge, cooling tower, flue termination, or vent termination.

3.3.12.2.2 Specified filters are installed. Check for leakage around filters.

3.3.12.2.3 Cooling coil drain pans have a positive slope to drain.

3.3.12.2.4 Cooling coil condensate drain trap maintains an air seal.

3.3.12.2.5 Evidence of water damage.

3.3.12.2.6 Insulation in contact with the supply, return, and outside air is dry and clean.

3.3.12.3 Measure and record indoor conditions served by each HVAC system. Make measurements at multiple locations served by the system if required to satisfy the following:

3.3.12.3.1 Most remote area.

3.3.12.3.2 One location per floor.

3.3.12.3.3 One location for every 5000 sq. ft. (500 sq. m).

3.3.12.4 Measure and record the following indoor conditions for each location two times at two-hour intervals, and in accordance with ASHRAE 113:

3.3.12.4.1 Temperature. Relative humidity. Air velocity.

3.3.12.4.2 Concentration of carbon dioxide (ppm).

3.3.12.4.3 Concentration of carbon monoxide (ppm). Nitrogen oxides (ppm).

3.3.12.4.4 Formaldehyde (ppm).

3.3.13 Procedures for Reliability Trial Test

3.3.13.1 After finishing the above tests and adjustments, the Contractor shall be responsible for running a reliability trial test for the whole plant installed.

3.3.13.2 The whole of the trial of the Cooling Plant shall take place during the period between the 15th June and 15th September, and the Heating Plant during the period between the 30th November, and 1st March. The Ventilation trial shall take place at any reasonable time subject to the approval of the Engineer.

3.3.13.3 The trial shall last for a period of 15 consecutive days and nights during which time the whole of the plant shall operate continuously, without adjustment or repair to the satisfaction of the Engineer.

3.3.13.4 During the reliability trial test, performance tests shall be conducted on the Refrigerating Plant, the Heating Plant and the air handling equipment.

3.3.13.5 The test data shall not deviate by more than three percent (3%) from the guaranteed capacity data.

3.3.13.6 Temperature readings shall be taken for the entering and leaving air of each air handling unit.

3.3.13.7 Should any part of the apparatus or system fail to meet the Contract requirements, it shall be adjusted, repaired or replaced to the satisfaction of the Engineer. The complete performance test shall then be repeated.

3.3.13.8 A 'Taking Over Certificate' with or without reservations shall be issued by the Engineer on the satisfactory completion of all the tests, provided that these reservations are of minor importance and will not hinder the satisfactory operation of the Plant.

3.3.14 Procedures for Testing. Adjusting. And Balancing Existing Systems

3.3.14.1 Perform a preconstruction inspection of existing equipment that is to remain and be reused.

3.3.14.1.1 Measure and record the operating speed, airflow, and static pressure of each fan.

3.3.14.1.2 Measure motor voltage and amperage. Compare the values to motor nameplate information.

3.3.14.1.3 Check the refrigerant charge.

3.3.14.1.4 Check the condition of filters.

3.3.14.1.5 Check the condition of coils.

3.3.14.1.6 Check the operation of the drain pan and condensate drain trap.

3.3.14.1.7 Check bearings and other lubricated parts for proper lubrication.

3.3.14.1.8 Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

3.3.14.2 Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished.

3.3.14.2.1 New filters are installed.

3.3.14.2.2 Coils are clean and fins combed.

3.3.14.2.3 Drain pans are clean.

3.3.14.2.4 Fans are clean ..

3.3.14.2.5 Bearings and other parts are properly lubricated.

3.3.14.2.6 Deficiencies noted in the preconstruction report are corrected.

3.3.14.3 Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work ..

3.3.14.3.1 Compare the indicated airflow of the renovated work to the measured fan airflows and determine the new fan, speed, filter, and coil face velocity.

3.3.14.3.2 Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are with.in the acceptable limits defined by equipment manufacturer.

3.3.14.3.3 If calculations increase or decrease the airflow and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated airflow and water flow rates. If 5 percent or less, equipment adjustments are not required.

3.3.15 Air balance each air outlet. Procedures for Acceptance Tests

3.3.15.1 As soon as possible after carrying out the Reliability Trial Test, and during the Maintenance Guarantee Period, the Contractor shall carry out, unless otherwise agreed, the Acceptance Test Specified in the relevant American or British or approved equivalent Standard Specifications, as well as much additional tests at Site, deemed necessary by the Engineer, to determine that the Works comply with the Specifications and provided that the Works are put into operation.

3.3.15.2 The date of commencement of the above said tests shall be subject to agreement with the
3.3.15.3 Engineer.

3.3.15.4 As soon as all tests prescribed in the section are carried out satisfactorily in the opinion of the Engineer, an official statement to that effect (herein referred to as Acceptance Certificate) shall be drawn up in three (3) copies and signed by the Engineer and the Contractor. One copy of the Acceptance Certificate shall be delivered to the Contractor.

3.4 Guarantee and Warranted Period

3.4.1 All equipment and accessories supplied by the nominated Sub-Contractor under this contract shall be guaranteed for a minimum period of one year from the date of final completion certificate.

3.4.2 All guarantee shall be unconditional. In the event of breakdown, the Contractor shall immediately provide and install a replacement unit of equal or superior performance until such time as the original unit is repaired. Failure by the Contractor to comply within 6 hours of notification, will entitle the Employer to purchase or hire a replacement and seek reimbursement from the Contractor for all related disbursements.

3.4.3 The Contractor shall guarantee every piece of equipment from any manufacturing or installation defects for a period of one year, starting from the date of issue of the substantial completion certificate.

3.5 Maintenance During Defects Liability Period And Guarantees

3.5.1 Starting from the date of issue of the Substantial/Provisional completion certificate the contractor shall be responsible, for the duration of one year, to provide the following services free of charge, at his own cost-

3.5.2 The training of operators assigned by the client for operation of all major equipment and controls as decided by the Engineer.

3.5.3 Training should be provided by original suppliers of equipment for a period of at least one week and or when requested by Client throughout the liability period.

3.5.4 The replacement of parts or whole equipment that show any manufacturing or installation defects during operation.

3.5.5 Carry out routine preventive maintenance (fortnightly, monthly, quarterly, half yearly and yearly as applicable to the approval of the Engineer) including provision of labour, parts and supply of consumable materials such as Replaceable air filters, Chemicals for Chilled Water System, Chemicals for Swimming Pool, Lubricants and Refrigerant Gas, required for the safe operation and guarantee of performance of all the systems but not limited to;

a. VRF System
b. Pumps,
c. AHUs, FCUs,
d. Fans,
e. BMS

3.5.6 Necessary staff to carry out the above shall be provided to the job site during the said year.

3.5.7 On call emergency services (24 hours), particularly for elevators, escalators, revelators and fire alarm system.

3.5.8 Guarantee of every piece of equipment from any manufacturing or installation defects for a period of one year.

3.5.9 At the end of defects liability period the contractor shall be responsible for final handing over of all installed systems in a perfect condition to the satisfaction of both Engineer and client.

3.6 Extended Defects Liability and Guarantees

3.6.1 The Contractor shall issue a letter of guarantee for every compressor installed under his contract for a period of five years, starting from the date of issue of the completion certificate. Contractor shall remove the defective compressor and install a new one at his own expense including all necessary accessories and shall do the necessary testing and commissioning. Contractor shall submit a report to the Engineer explaining the reason of damage and methods to prevent it from happening.

3.6.2 The Contractor shall issue in favour of the client all original manufacturers extended guarantees as required by specifications or by Engineers approval conditions or by manufacturers initial proposal prior to final handing over to the client.

3.7 Maintenance and Guarantee

3.7.1 The Contractor shall submit along with his quotation a separate price for the maintenance of all of the Air Conditioning and plumbing works. The price shall be good for two consecutive years after the end of the maintenance period.

3.7.2 The price shall cover, but shall not be limited to the following items:

3.7.2.1 Yearly Maintenance

3.7.2.1.1 At the end of each year all equipment shall be serviced (checked and repaired), i.e... compressors, motors, pumps, heaters fans, etc.

3.7.2.2 Weekly Inspection

3.7.2.2.1 Competent technical representatives of the Contractor shall make weekly inspections to the plant and record the following readings on special log sheets:

3.7.2.2.2 Discharge and suction pressure and oil pressure of each packaged unit.

3.7.2.2.3 Power consumption (Amps) of each compressor, condenser fan, pump motor, heater, .etc.

3.7.2.2.4 Any inconsistency in the above readings or non compliance with manufacturers data shall be looked into by the Contractor; and after the cause is identified, he shall rectify and report it to the client. In the weekly inspection, the Contractor should make sure that the (AIC) design conditions inside the spaces are maintained and to the satisfaction of the occupants and that no machine or equipment is creating excessive noise.

3.7.2.3 Monthly Inspection

3.7.2.3.1 The Contractor's representative shall make the following monthly inspections:

3.7.2.3.1.1 Check and clean air filters of air handlers, fan coil units, fresh air grilles, etc ..

3.7.2.3.1.2 Check insulation of A/C pipes, ducts and check evidence of any condensation & do the necessary repairs.

3.7.2.3.1.3 Clean drain pans and drain pipes of all air handlers and fan coil units.

3.7.2.3.1.4 Check, adjust, and calibrate control system of air handlers and fan coil units.

3.7.2.3.1.5 Check and tighten belts of all fans.

3.7.2.3.1.6 Check the compressor's oil and refrigerant gas quantities and maintain always the required quantity.

3.7.2.4 Spare Parts

3.7.2.4.1 Contractor shall immediately replace any damaged or faulty item; spare parts should be always available. Parts shall be replaced at the cost of the Contractor.

3.7.2.5 Exclusions

3.7.2.5.1 Contractor shall submit a list of exclusions (if any) to the above, which he thinks are not part of his responsibilities or duties.

3.7.2.6 Contractor's Attendance

3.7.2.6.1 The Contractor is expected to respond to all requests from owner or owner's representative or owner's consultant to attend to the faults within 24 hours from the time he is called upon. He shall carry the necessary service as per the terms of the maintenance contract.

3.7.2.7 Guarantees

3.7.2.7.1 The contractor shall give the following guarantees for the following equipment whereby he shall immediately replace the same whenever found defective.

- Compressors 5 years
- Pump motors 5 years
- Condenser fins. 15 years
- Evaporators 15 years
- Air Handlers motors 5 years
- Air Handler casing against any rust, or corrosion or discoloration 10 years

End of Section 23 05 93.

SECTION 23 07 00

HVAC INSULATION

SECTION 23 07 00

HVAC INSULATION

PART 1 GENERAL

Works of this Section shall be governed by Conditions of Contract.

1.1 Scope of Work

1.1.1 Supply and install all insulation and lagging on piping, vessels or ducts as indicated on the drawings or specified to be insulated.

1.1.2 All insulation material shall have Zero Ozone Depletion Potential (ODP=O) and less than Five Global Warming Potential (GWP < 5)..

1.1.3 Canvas jacket and all insulating materials shall be non-combustible, or self-extinguishing non-flame spread grade.

1.1.4 Insulation in exposed areas, i.e. permanently visible, shall be protected with aluminium cladding as specified herein after.

1.2 Related Works Specified Elsewhere

1.2.1 All items specified in this section are included in each of following divisions, sections and sub-sections as applicable, as if repeated therein verbatim.

Section 23 05 00 - Common Works Results for HVAC
Section 23 0900 - Instrumentation and Controls for HVAC
Section 23 20 00 - HVAC Piping and Pumps
Section 23 30 00 - HVAC Air Distribution
Section 2340 00 - Air Cleaning Devices
Section 23 50 00 - Central Heating Equipment
Section 23 60 00 - Central Cooling Equipment
Section 23 70 00 - Central HVAC Equipment
Section 23 8000 - Decentralized HVAC Equipment

1.3 Schedule of Insulation Thickness

1.3.1 The thickness of the insulation applied to pipes, ducts and equipment shall be as stated hereinafter

Service	Location	Pipe Diameter inches (mm)	Insulation Thickness inches (mm)
- A/C condensate drain pipes	-	-	½(13)
- Supply and return air ducts	In conditioned spaces	-	1½ (38)
- Ditto	In unconditioned spaces	-	2 (50)
- Untreated fresh air duct	Passing through air plenum	-	1 (25)
- Refrigerant suction and liquid lines	-	-	¾ (20)

1.4 Codes and Standards

1.4.1 Codes and standards applicable to this section shall be primarily British Standards and United States Codes, unless otherwise specified, the performance/manufacturing standards of items mentioned in this section shall confirm to the applicable portions of the latest editions of the following codes, standards and regulations.

Reference Code	Abbreviation	Applicable Standard	Title of Standard
National Fire Protection Association	NFPA	NFPA 90A NFPA 90B	Standard for Air Conditioning and Ventilating Systems. Standard for warm Air Heating and Air Conditioning Systems.
American Society for Testing and Materials	ASTM	ASTM E96	Test method for water vapour transmission of materials

PART 2 PRODUCTS

2.1 Duct Insulation

2.1.1 Duct insulation in air-conditioned spaces shall be blankets of fibrous glass with a density of not less than 1.5 Ib/ft3 (24 kg/m3) and a K-factor of not more than 0.26 Btu-in/ft2 hr. deg. F (0.038 W/m deg. K) at a mean temperature of 75 deg. F (24 deg C) for concealed insulation.

2.1.2 Duct insulation in unair-conditioned spaces, mechanical rooms, and shafts shall be rigid board of fibre glass with a resin binder and a density of not less than 4 *Ib/ft3* (64 kg/m2) and a K-factor of not more than 0.25 Btu-ln/ft2. hr. of (0.036 W/m o K) at a mean temperature of 75^{o} F (24^{o} C) for outdoor application.

2.1.3 For cold air application, insulation shall be faced with factory applied reinforced foil and paper which comprises aluminium foil reinforced with fiberglass yarn mesh and laminated to 40 Ibs chemically treated fire retardant Kraft.

2.1.4 50 x 50 x 0.6 mm galvanized sheet metal angles shall be attached at corners.

2.2 Pipe Insulation - Type B

2.2.1 This type of insulation shall apply to Refrigerant pipes and *AlC* condensate drain pipes.

2.2.2 Insulation shall be flexible foamed closed cell elastomeric tublar form type. Insulation may be slipped over pipe or tubing before pipe connections are made, or may be slit longitudinally and snapped onto the pipe and then sealed with vapour barrier adhesive.

2.2.3 Insulation shall have a thermal conductivity not greater than 0.27 BTU / Hr OF. ft sq. per inch thickness at a mean temperature of 75 ° F.

2.2.4 The surface finish shall be an 8-ounce canvas cloth embedded between 2 coats of vapour barrier. Aluminium cladding shall be provided as specified.

2.3 Vapour Barrier Coating

2.3.1 The vapour barrier coating shall be tough flexible fire resistive elastomeric finish for protection of thermal insulation. It shall meet the requirements of NFPA 90A and 90B and shall be UL classified.

2.3.2 The vapour barrier shall have water vapour permeability not more than 0.02 perms at 0.75 mm dry film thickness when tested to ASTM E96 Method.

2.3.3 When tested for surface burning characteristics (ASTM E84) it shall have a flame spread rating not exceeding 10 and smoke developed not higher than 15.

2.3.4 The vapour barrier shall be suitable for application by brush or spray. It shall be applied in 2 coats with heavy duty fire retardant canvas cloth (8 ounce) embedded between the coats. Canvas overlap at joints shall be at least 50 mm. The wet film thickness of each coat shall be at least 1.25 mm.

2.3.5 Vapour barrier coating shall be applied above thermal insulation of G.I. Ducts, Water supply (hot and cold), refrigeration and condensate drain pipes.

2.4 Aluminium Cladding

2.4.1 Aluminium cladding shall be of 20 gauge it shall be used as protection against weather and mechanical damage.

2.4.2 Aluminium cladding shall be applied on top of insulation above the canvas jacket and vapour barrier coating. It shall be held in place by means of self tapping screws and by using 38 mm wide aluminium straps at 300 mm centers with aluminium or stainless steel angle rib clips, all joints shall be sealed with grey coloured suitable sealant. Rivets and screws shall not be used for cladding unless approved by the Engineer for use on elbows and fittings. Cladding shall be overlapping at joints, horizontal seams shall be at the bottom. Cladding on ducts shall be formed in such a way to allow for rain/dew drain off.

2.4.3 Fabricated 20 gauge aluminium covers shall be used for valves and fittings. The covers shall be in two sections hinged together and held in place by suitable stainless steel/aluminium clasps.

2.4.4 Aluminium cladding shall be applied to all insulated ducts running exposed on roof, outside building, inside parking floors and in plant rooms.

PART 3 EXECUTION

3.1 Protection and Cleaning

3.1.1 All insulation shall have a smooth, homogenous and lineable finished surface. All rigid sections shall be concentric and be accurately matched for thickness.

3.1.2 All surface to be insulated shall be dry and free from loose scale, dirt, oil or water when insulation is applied.

3.1.3 Insulation shall be applied in such a manner that air circulation within the insulation or between the insulation and the pipe shall be avoided.

3.1.4 No surface imperfections in the insulation such as damaged edges, or ends, cracks and small voids or holes shall be accepted.

3.1.5 Insulation materials shall be stored and protected from weather moisture, accumulations of foreign matter, or possible damage in a dry and clean store.

3.1.6 Surface finishes and lagging adhesives shall not be diluted and shall be applied in accordance with the manufacturer's instructions.

3.1.7 Apply insulation to permit expansion or contraction of metal without causing damage to insulation or surface finish.

3.2 Installation of Equipment and Duct Insulation

3.2.1 Curved or cylindrical equipment shall be insulated with blocks or curved segments in one layer for thicknesses of 65 mm or less and two layers for thicknesses of 76 mm or more. The insulation shall be applied with joints staggered and tightly butted together and held in place with bands. Square cornered equipment such as boilers, ducts casings etc. shall be insulated with block insulation protected at corners by metal shields and held in place by bands, carried around the unit over the insulation and fastened tight.

3.2.2 Metal anchoring clips shall be welded to the equipment surface so that the band will pass over them and may be wired to them after insulation is in place.

3.2.3 Insulation in exposed areas, i.e. permanently visible, shall be protected with aluminium cladding as specified.

3.2.4 Any part of equipment that is normally removable for service such as heads of heat exchangers, shall be insulated separately from the equipment.

3.2.5 No insulation shall be applied over nameplates.

3.2.6 Insulated ducts penetrating walls or floors shall be insulated completely thru penetration. Provide waterproof calcium silicate insert, same thickness and jacketing as insulation with wall flange for fire wall or floor penetrations, or as detailed on the Drawings.

3.2.7 Duct insulation or lining or any type of covering together with the applied adhesives shall have a flame spread rating not over 25 without evidence of continued progressive combustion and a smoke developed rating no higher than 50, wherever the duct crosses a fire wall or penetrates a roof slab.

3.2.8 Duct linings shall be interrupted at fire dampers and fire doors so as not to interfere with the operation of services.

3.2.9 All duct materials and coverings (insulation, pre-insulated panels, linings, etc.) shall meet the requirements of NFPA 90A and 90B Standards or equivalent European Standards.

3.2.10 Adhesives, sealants, vapour barriers, paints, etc., shall meet the requirements of NFPA 90A and 90B and shall be UL Classified.

3.3 Approved List of Manufacturers:

3.3.1 For accepted products, Manufacturers and suppliers, refer to Appendix A.

<u>End of Section 230700.</u>

SECTION 23- 0900

INSTRUMENTATION AND CONTROLS FOR HVAC

SECTION 23 09 00

INSTRUMENTATION AND CONTROLS FOR HVAC

PART 1 GENERAL

1.1 Scope of Work

1.1.1 The contractor shall supply and install all the control equipment, auxiliary devices, instruments, etc. to perform satisfactory operations of all systems described in the specifications and/or indicated on the Drawings. The Drawings and the specifications are complemented each to the other.

1.1.2 The sequence of operation of each system or piece of equipment is specified either under the equipment specification section or detailed on the Drawings.

1.2 General Requirements

1.2.1 Control system shall be of the electronic type, (solid state) to provide the required sequence of operation.

1.2.2 Provide all relays, switches, gauges, sources of electricity and all other auxiliaries, accessories and connections necessary to make a complete operable system.

1.2.3 Unless stated otherwise temperatures shall be controlled within plus or minus 2 degree F (1 degree C) and humidity within plus or minus 5 per cent of the set point.

1.2.4 Provide positive positioner devices on all controls operated in sequence and/or where specified or required to maintain the set point within the required limits without override.

1.2.5 Basic components shall be standard catalogue products of single reputable Manufacturer.

1.2.6 Do not duplicate factory furnished controls of unitary equipment like refrigeration machines, fan coil units, etc. but modify them to conform to these specifications:

1.2.7 Obtain from the manufacturer of unitary equipment, and submit written certification that proposed control circuit modifications do not conflict with or invalidate Manufacturer's equipment warranty.

1.2.8 The equipment shall be restarted after a power failure in the same sequence and with the same time delays as specified for normal start-up.

1.2.9 Select the instrument so that the normal range of operating temperatures and pressures falls within the middle-third of the instrument range. Use compound gauges when normal operating pressure is near or below atmospheric.

1.2.10 Where thermometer sensing bulbs are inserted in air ducts or casings, provide perforated bulb housing with a 3" (80 mm) diameter union flange to permit removal. Connections for sensing elements are to be brass except where otherwise specified. Provide all thermometers in piping systems with stainless steel wells and %" (20 mm) separable sockets.

1.2.11 Provide extension necks where thermometers and pressure gauges are located in insulated piping, vessels, ductwork, casings or equipment.

1.2.12 All thermometers and gauges shall have both English and metric units grading.

1.3 Shop Drawing

1.3.1 Shop Drawings shall be schematic diagrams showing all the components of the control systems and the interconnection scheme. Each component shall be identified by name and/or schedule number of equipment item it controls.

1.3.2 Manufacturer's detailed Shop Drawings, specifications, and data sheets for all equipment to be furnished shall be submitted to the Engineer for approval.

1.4 Related Works Specified Elsewhere

1.4.1 The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated herein verbatim. However, any discrepancies between the content of this section and what is shown in Division 25, the specification in Division 25 shall take precedence.

Section 230500 - Common Works Results for HVAC
Section 230700 - HVAC Insulation
Section 23 09 00 - Instrumentation And Controls for HVAC
Section 23 20 00 - HVAC Piping and Pumps
Section 23 30 00 - HVAC Air Distribution
Section 234000 - HVAC Cleaning Devices
Section 23 70 00 - Central HVAC Equipment
Section 23 80 00 - Decentralized HVAC Equipment
Division 25 - Integrated Automation

PART 2 PRODUCTS

2.1 Control Panel and Control System

2.1.1 Control panels shall be installed where shown and as required on the Drawings. Each panel shall include start-stop and pilot lights for all major equipment being controlled together with their starters and necessary heat detector, alarm and other related safety and fire alarm systems.

2.1.2 The control system shall be complete with all necessary transformers, thermostats, valves, dampers, damper operators, and associated regulators required to maintain the conditions desired together with the thermometers, gauges, and other necessary accessories and the control wiring.

2.2 Temperature Controllers (With Remote Sensors)

2.2.1 Shall be supplied complete with metal cases and manual set point adjusters.

2.2.2 Room type controllers shall be mounted 1800 mm above the floor and in an accessible location.

2.2.3 Panel-mounted controllers shall be supplied with metal mounting adaptor plate and mounting assembly.

2.2.4 Controllers shall be designed for a throttling range of 2 OF (1 ° C) for a 3Vdc output change with a control dial range 55-85 ° F (13-29 DC) and shall be suitable for ambient operating limits 40-135 OF(4-57 DC).

2.3 Temperature Sensors

2.3.1 Refer to Section 25 50 00 - Integrated Automation Facility Controls.

2.4 Room Thermostats

2.4.1 Shall have metal locking covers and shall be provided with concealed adjustment means, and with thermometers.

2.4.2 Each room thermostat shall be supplied with metal auxiliary mounting bases and metal sub-base for surface mounting applications; plus a plastic guard to protect thermostat from damage.

2.4.3 Line voltage on/off thermostats shall be of the bimetal operated snap action switch. They shall be underwriters' laboratories inc., listed at an electrical rating appropriate to the application. Thermostat shall operate on 2 OF (1°C) differential and shall have a control dial range 55-85 deg F (13-29 deg C).

2.4.4 Low voltage thermostats shall be of the self contained type with a 1000 ohm sensing element and an amplifier. Thermostat shall have a control dial range 55-85 deg F (13-29 deg C) and a throttling range of 2 OF(1°C) for a 3 Vdc output change.

2.5 Control Motor (Actuator)

2.5.1 Electric, reversible, spring-return, proportional type complete with linkage.

2.5.2 Suitable for damper operation.

2.5.3 Shall be sized to operate with sufficient reserve power to provide smooth modulating action or two-position action as specified.

2.6 Humidity Sensors

2.6.1 Refer to Section 25 50 00 - Integrated Automation Facility Controls.

2.7 Data Control *(Ole)* and Graphics Summary

2.7.1 All hardware, custom software, application software, graphics, etc., necessary to accomplish the control sequences and display the graphics specified shall be provided as part of this contract. Provide all controllers, inputs, outputs, valves, dampers, actuators and flow meters required to provide the control and graphic data described. Provide software set-points required for display in logical groups and graphics.

2.7.2 Each digital output shall have a software-associated monitored input. Any time the monitored input does not track it's associated command output within a programmable time interval, a "command failed" alarm shall be reported. Where calculated points (such as l/s) are shown, they shall appear in their respective logical groups.

2.7.3 Unless otherwise specified or approved prior to bidding, the primary analog input and the analog output of each DOC loop shall be resident in a single remote panel containing the DOC algorithm,. and shall function independent of any primary or UC communication links. Secondary (reset type) analog inputs may be received from the primary network, but approved default values and lor procedures shall be substituted in the DOC algorithm for this secondary input if network communications fa i.! or if the secondary input becomes erroneous or invalid.

2.7.4 In addition to the Unitary DOC Controller data points specified to be presented on colorgraphic displays, technical data for each zone mechanical apparatus shall be presented to operators on the OWS in full English menu text displays including the apparatus name; heating and cooling PID loop P, I and D gains; primary is airflow (if measured); damper position (% open); reheat status/value; cooling setpoint; heating dead-band; minimum and maximum is setpoints; reheat is setpoint; unoccupied temperature setpoint; temperature sensor calibration offset and bypass push button time, in minutes. All such points shall be presented in complete and direct read-write (command) format, unless they are provided in commendable colorgraphic displays.

2.7.5 In addition to Graphics of building systems with dynamic data points shall be provided for each mechanical and electrical equipment but not limited.

2.8 Unitary DOC Controllers

2.8.1 All FCU's in lobbies and mechanical rooms shall be provided with DOC based controller with PID control action. The controller shall have communication capability with the 8MB. The BMS shall have the capability of resetting the temperature setpoint on the FCU Controller.

2.9 Solenoid Valves

2.9.1 Solenoid valves shall be the piston type suitable for cold water, hot water, steam, fuel, oil and other non-aggressive media up to a temperature of 180C. Solenoid Valves shall be sized for 1600kPa with actuators 240Vac.

2.10 Transducers

2.10.1 Analog output transducers shall be designed for precision closed loop control with pneumatic repeatability error no greater than 1% or equal approved.

2.11 Selector Switches Auto/Off/On

2.11.1 Manual override switches AUTO/OFF/ON shall be part of DOC panel/controller. The switches shall be installed in side of DOC panel with necessary auxiliary contacts to DOC controller to indicate selector position. The manual override function shall be available even if the DOC/CPU is failed. The 8MS contractor shall be responsible to coordinate proper connection between the selector switches and starters and ensure that the switches shall provide manual override functions in case that DOC/CPU fails.

2.12 Thermometers

2.12.1 Permanently installed thermometers shall be mercury-in-steel dial type 150mm diameter having a suitable length of copper covered steel capillary tubing to connect the dial with The bulb shall be supplied and installed as specified and as approved by the Engineer. Each thermometer shall be provided with back flange or arranged for flush mounting.

2.12.2 In-glass type thermometers with metal guard shall be supplied and installed as specified or as approved by the Engineer. Unless otherwise specified, thermometer bulbs shall be of steel type, screwed %" (20mm) British Standard pipe and supplied with stainless steel separable pockets suitable for screwing, brazing or welding into the pipe carrying the medium to be measured.

2.12.3 Thermometers shall be tested to read alike on the midscale band, with their bulbs immersed in water, and the discrepancy between the highest and the lowest thermometer shall not exceed 0..5 degree C.

2.12.4 A red mark on each thermometer scale shall indicate the working temperature at the point of measurement.

2.12.5 Thermometers shall be marked in both Degree C and Degree F.

2.13 Pressure Gauges

2.13.1 Bourdon-tube type with 120 mm. diameter cast aluminium case with moisture-proof and dustproof blowout discs. Panel mounted gauges to have steel or aluminium hinged rings; direct mounted gauges to have back flange, black numerals on a white background face.

2.13.2 Pressure gauge shall be furnished with a lever-operated gauge cock, and shall have snubbers installed between the gauge cock and the gauge to eliminate pulsations.

2.13.3 Bourdon Tube shall be Phosphor bronze, (beryllium copper bellows). Socket shall be Stainless steel.

2.13.4 Accuracy shall be at least 1% of scale range , range shall be equal to twice the rated working pressure of the unit (pumps, chillers, ...) reading shall be in psi. and Kpa.

2.13.5 Gauges for combined pressure and vacuum service to have compound seal.

2.14 Gauge Test Points

2.14.1 Gauge test points for temperature and pressure of flow shall be installed in all systems and particularly pairs of valves for regulating mains at flow and return connections to all plant and at all thermostatic elements and sensors.

2.14.2 Pressure gauge test points shall consist of 6mm. bore bosses in the pipe work fitted with a test cock and plugged *off.*

2.14.3 Air flow test points shall be provided in the air ducting at all branches and regulating dampers adjacent to each plant item and automatic control element at all fan inlets and discharges and elsewhere as required.

2.14.4 Test points shall consist of a 40mm. diameter hole drilled through the ducting and covered with a removable spring clip fastened cover.

2.15 Filter Condition Indicators

2.15.1 Indicators shall be provided for all air filter units on air handlers and main fresh air louvers. The indicators shall be spirit or moving vane type suitably calibrated and provided with flexible pressure tubes to a test point on each side of all 'roughing' and 'fine' filters.

2.15.2 The position on the gauge dial at which the filters require cleaning or changing shall be clearly marked.

2.16 Flow Meters

2.16.1 Supply and install flow meters in the primary chilled water flow line and each refrigeration machine delivery line. The meter connections and cocks shall be carried well above the line.

2.17 Water Flow Switches

2.17.1 Water flow switches shall be of the paddle type electric as manufactured by the McDonnell and Miller Company. Those flow switches used in chilled water applications shall be of the vapor proof type to prevent condensation on the electrical switch.

2.17.2 Paddles shall be properly trimmed for the pipe sizes in which they are installed. The flow switches shall be installed in accordance with manufacturer's recommendations regarding locations in horizontal piping and proper distance from fittings.

2.18 Firestats

2.18.1 Provide manual reset firestat for each fan of 750 cfm (0.35 m3/sec) or larger capacity, to stop the fan on rise above set point temperature 136 OF(58 ° C).

2.19 Freezestats

2.19.1 Provide a freezestat for each water coil subject to freezing to protect coil by deenergizing the supply fan when triggered.

2.19.2 Freezestats shall be remote bulb, 20 ft (6 m) averaging type, with manual reset, adjustable setpoint, 15 degrees F to 55 degrees F., (-9 to 13°C) mechanical stop to limit control point adjustment below predetermined minimum.

2.20 Smoke Detectors

2.20.1 Supply and install duct mounted smoke detectors as shown on the drawings and as required by NFPA code.

2.20.2 Smoke detectors shall be as specified under the Fire Alarm System section of the specifications.

2.20.3 Smoke detectors shall be supplied complete with the necessary power relays and control wiring to perform the proper operations and function specified in the A/C units control diagrams.

2.21 Ammeters

2.21.1 One 100 mm dial ammeter shall be supplied for each motor 10 HP (7.5KW) or larger, and for all electrical apparatus fed from the control panel. Ammeter shall be red lined at the normal running load.

2.22 Voltmeters

2.22.1 One 150 mm dial voltmeter shall be supplied to indicate the voltage of the motor control center in each Plant-Room.

2.22.2 The Voltmeter shall be complete with a seven-position, rotary switch to enable reading the voltage between all phases and neutral.

2.23 Air Flow Switches' & Dirty Filter Switches

2.23.1 Differential type pressure switches shall be provided for these applications. The switch shall be complete with connecting tube and metal bends for connections to the duct.

PART 3 EXECUTION

3.1 Installation

3.1.1 Install controls so that adjustments and calibrations can be readily made.

3.1.2 Unless otherwise noted, install all wall mounted thermostats 1400 mm above the floor, measured to the center line of the instruments.

3.1.3 Install all control valves horizontally with the power unit up.

3.1.4 Instrument wire shall be run in conduits separate from other types of wiring and shall terminate on identified terminal strips.

3.1.5 The wire terminals on instruments shall not be used as junction points to facilitate removal of instruments without disturbing others.

3.1.6 Instruments shall have laminated plastic name tags with tag numbers and service engraved on the tag. Tags shall be securely fastened to the instrument. Tags shall be black with white lettering

3.1.7 Mount pressure gauges directly at the sensing point unless otherwise indicated.

3.1.8 Locate temperature sensing devices in a portion of the fluid stream where it will measure the average fluid temperature without obstructing flow. Increase pipes 1 ½" (40 mm) in diameter and smaller at least one pipe size at the point of insertion.

3.2 Testing

3.2.1 After completion of installation, all automatic controls shall be regulated and adjusted and placed in complete operating conditions subject to the approval of the Engineer and a maintenance brochure including all operating instructions, specifications and sheets for all instruments shall be submitted by the Contractor.

3.2.2 After all controls, valves and motors have been connected, test the systems in the presence of the Engineer to demonstrate the capability of each automatic control system to meet contract requirements.

End of Section 23 09 00.

SECTION 23 23 00

REFRIGERANT PIPING

SECTION 23 23 00

REFRIGERANT PIPING

PART 1 GENERAL

1.1 Introduction

1.1.1 Works of this Section shall be governed by Contract Conditions.

1.1.2 This section describes basics materials and requirements for refrigerant piping work services installations for building.

1.2 Related Works Specified Elsewhere

1.2.1 The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated herein verbatim.

Section 23 05 00 - Common Works Results for HVAC
Section 23 07 00 - HVAC Insulation
Section 23 09 00 - Instrumentation And Controls for HVAC
Section 23 3000 - HVAC Air Distribution
Section 23 70 00 - Central HVAC Equipment
Section 23 80 00 - Decentralized HVAC Equipment

1.3 Pipe Identification

1.3.1 All pipes shall be indelibly marked at intervals of not greater than 3m. The marking shall show the manufacturer's identification, the standard name and number, and the nominal size and class. Adhesive labels alone shall not suffice. All pipes complying with British Standards shall be kitemarked.

1.4 Codes and Standards

1.4.1 Codes and standards applicable to this section shall be primarily British Standards and United States Codes, unless otherwise specified, the performance/manufacturing standards of items mentioned in this section shall confirm to the applicable portions of the latest editions of the following codes, standards and regulations.

Reference Code	Abbreviation	Applicable Standard	Title of Standard
American Water Works Association	AWWA	C601-68	
		C501-67	
American Society for Testing and Materials	ASTM	ASTM A53-88a	Specification for pipes, steel, black and Hot-Dipped, Zinc-Coated, Welded and Seamless
		ASTM B280-88	Specification for seamless copper tube for A/C and refrigeration field service
		ASTM A307	Specification for Carbon Steel Bolts and Studs. 60,000 psi tensile Strength

		ASTM D1785	Specification for poly (vinyl chloride) (PVC) plastic pipe schedules 40, 80, and 120.
American Standards Association	ASA	ASA 40.1	-
		ASA B16.22	-
		ASA B1618	-
		ASA B9.1	-
		ASA B35.5	-
British Standards	BS	BS 4514	Specification for unplasticized PVC soil and venting pipes, fittings and accessories.
		BS 5255	Specification for thermoplastics waste pipe and fittings.
		BS 5254	Specification for polypropylene waste pipe and fittings (external diameter 34.6 rnm, 41.0 mm and 54.1 mm)
		BS 3505	Specification for unplasticized polyvinyl chloride (PVC-U) pressure pipes for cold potable water
		BS 4346 Part 1	Joints and fittings for use with unplasticized PVC pressure pipes. Injection moulded un plasticized PVC fittings for solvent welding for use with pressure pipes, including potable water supply.
		BS4346 Part 2	Mechanic joints and fittings, principally of unplasticized PVC.
		BS 4660	Specification for unplasticized polyvinyl chloride (PVC-U) pipes and plastics fittings of nominal sizes 110 and 160 for below ground gravity, drainage, and Sewerage
		BS 5481	Specification for unplasticized PVC pipe and fittings for gravity sewers
		BS 1387	Specification for screwed and socketed steel tubes and tubular and for plain and steel tube suitable for welding or for screwing to BS21 p
		BS 2871	Specification for copper and copper alloys, tubes.

		BS 864 Part 2	Specification for capilary and compression fittings for copper tubes
		BS 3601	Specification for carbon steel pipes and tubes with specified room temperature properties for pressure pipes.
		BS 21	Specification for pipe threads for tubes and fittings where pressure light joints are made on the threads.
American Society for Heating, Refrigeration and Air Conditioning Engineers	ASHRAE		-
Deutches Institute for Normung	DIN	DIN 19534	-
American National Standards Institute	ANSI	ANSI B18.2.2	-
		ANSI B31.1	
		ANSI A21, 10, 11	

PART 2 PRODUCTS

2.1 Copper Pipes-CuP-Type 3

2.1.1 Copper pipes shall be of the seamless hard drawn tubing type K or L to ASTM B280-88. Tubing, to be used, shall have been cleaned by the manufacturer and the open ends capped to preserve cleanliness.

2.1.2 Cup shall be designed, constructed and installed in compliance with ASA B9.1 and ASA B35.5 (safety code for Mechanical Refrigeration).

2.1.3 CuP shall be suitable for solder jointing with forged or wrought copper fittings.

2.1.4 Cast fittings should not be used because they might be porous and allow the refrigerant to leak.

2.1.5 Surfaces to be soldered shall be cleaned bright. The joints shall be given a thin coating of approved soldering flux and the tubing end inserted into the fitting as far as possible.

2.1.6 Heating and finishing of the joint shall be done in accordance with the recommendations of the manufacturer of the fittings. During the heating, the pipe and fittings must be kept full of an inert gas N or CO_2 to prevent formation of scale.

2.1.7 The solder metal to be used shall be a non-ferrous metal or alloy having a melting point below *BOO* OF(427°C) and below that of the metal being joined, an accepted solder is Sil- Fos to make copper to copper joints.

2.1.8 When solenoid valves are being installed, the coil should be removed, and no heat shall be applied near the bulb of the expansion valve.

2.1.9 CuP type 3 are allowed to be used to carry refrigerants and/or as specifically mentioned in the schedule of pipe materials.

2.2 UPVC Pipes Type 1

2.2.1 Polyvinyl chloride pipes (PVC) shall be of the un-plasticized rigid type and of high density and complete homogeneity material

2.2.2 UPVC Pipes - Type 1 shall comply with BS EN 1329-1 : 2000 specification for pipes, fittings and the system.

2.2.3 UPVC Pipes - Type 1 piping systems shall be used in the field of *NC* condensate drain.

2.2.4 UPVC Pipes Type 1 piping systems sockets and spigots shall be either for solvent cement joints or ring seal joints.

2.3 Joints Between Dissimilar Metals (Dielectric isolators)

2.3.1 Make joints between ferrous and non-ferrous screwed piping and equipment by usingTeflon or nylon isolating materials in the form of screwed unions.

2.3.2 Make joints between ferrous and non-ferrous flanged piping and equipment with insulating gaskets and "Teflon sleeves and washers between flanges, bolts and nuts.

2.3.3 The entire insulating joint including the dielectric material shall be suitable to withstand the temperature, pressure and other operating characteristics for the service for which they are used.

2.4 Piping Schedule

2.4.1 General

2.4.2 Piping classes are specified for each service in the following schedule. The designations indicated refer to detailed specifications for piping in this section of the specifications:

2.4.3 Piping classes

Service	Piping Class
- A/C Condensate drains	UPVC Type 1
- A/C Condensate drain above false ceiling	UPVC Type 2
- Refrigerant Pipes	UPVC Type 3

PART 3 EXECUTION

3.1 Arrangement and Alignment of Pipes

3.1.1 Install piping in a neat, workmanlike manner and the various lines shall be parallel to building walls shall be parallel to wherever possible.

3.1.2 Install refrigerant pipe groups in parallel with each other.

3.1.3 Support, anchor all piping to preclude failure or deformation. Construct and install hangers, supports and accessories to the approval of the Engineer. Do not use wire, tape or metal bands. Supports shall be designed to support weight of pipe, weight of fluid and weight of pipe insulation.

3.1.4 Fasten piping securely to the structure without overstressing any portion of the supports or the structure itself. Secure pipe supports, anchors and guides to concrete by means of inserts or if greater load carrying capacity is required by means of steel fishplates embedded in the concrete.

3.1.5 Uninsulated copper or brass pipe and/or tubing shall be isolated from ferrous hangers or supports.

3.1.6 Support piping and tubing at intervals indicated in the schedule hereinafter and at all changes in direction. Maximum deflection shall not exceed 3 mm.

3.1.7 Furnish pipe hangers and supports complete with rods, bolts, lock nuts, swivels, couplings, brackets and all other components and accessories, to allow installation to freely expand and contract. For copper or brass pipe, use plastic sheathed hangers. Pipe hangers shall fit over insulated piping.

3.1.8 Provide trapeze hangers where several pipes can be installed parallel and at the same level. Trapeze shall be of steel channel sized to support load and drilled for rod hanger at each end. Provision should be made to keep the lines in their relative position to each other by the use of either clamps or clips.

3.2 General Requirements for Piping Installation

3.2.1 Make all changes in size and direction of piping with standard fittings ..

3.2.2 Make all branch connections with tees.

3.2.3 Use eccentric reducing fittings or eccentric reducing couplings where required by the contract documents or where required to prevent pocketing of liquid or non-condensables.

3.2.4 Pipes and fittings shall both be manufactured according to one single standard unit of measurement, either both English and both metric.

3.2.5 Wall supports - provide for supporting horizontal piping from wall with steel J-Hook for pipe located close to wall.

3.2.6 Vertical piping supports - support pipes at every floor unless shown otherwise.

3.2.7 Provide penetration shields to encase insulated pipes penetrating fire walls or floors in a 360 o. 24 gauge minimum sheet metal hanger shields. Spacing between sleeve and insulation shield, pack annular space between sleeve and shield on both ends with double neoprene coated asbestos rope. Install an escutcheon plate to completely cover the wall penetration opening and fit snugly over the pipe insulation shield. Insert shall extend at least 25mm. beyond penetrated surface and escutcheon.

3.2.8 Maximum horizontal spacing for hangers are as follows:

- Up to 1¼"(32 mm) copper pipe----------2.0 meter
- 1 ½" (40 mm) and over copper pipe-------3.0 meter

3.3 Connection to Equipment and Control Valves

3.3.1 Provide connections to equipment and control valves to facilitate dismantling. Arrange connections so that the equipment being served may be removed without disturbing the piping.

3.4 Installation of Unions and Flanges

3.4.1 Unions and flanges shall be installed at all equipment inlets and outlets,

3.5 Pipe Sleeves

3.5.1 Provide all pipe openings through walls, partitions and slabs with sleeves having an internal diameter at least 50mm larger than the diameter of the pipe for un-insulated lines or of the insulation for insulated pipes.

3.5.2 Install sleeves through interior walls and partitions flush with finished surfaces; sleeves through outside walls to project 15mm. on each side of the finished wall; and floor sleeves to project 25mm. above finished floors.

3.5.3 Set sleeves in place before pouring concrete or securely fasten and grout in with cement.

3.5.4 Sleeve construction:

- Interior Partitions - galvanized sheet iron.
- Interior & Exterior Masonry Walls and Floors-galvanized steel pipe.

3.5.5 Fill the space between outside of pipe or insulation and the inside of the sleeve or framed opening with fibrous asbestos in interior walls and floors and pack with oakum, seal with watertight mastic or asphalt in exterior walls.

3.6 Cleaning of Piping Systems

3.6.1 Plug all opening ends of piping, valves and equipment except when actual work is being performed to minimize accumulation of dirt and debris.

3.7 Approved List of Manufacturers:

3.7.1 For accepted products, Manufacturers and suppliers, refer to Appendix A.

End of Section 23 23 00.

SECTION 2331 00

HVAC DUCTS AND CASING

SECTION 23 31 00

HVAC DUCTS AND CASING

PART 1 GENERAL

1.1 Introduction

1.1.1 This section includes the design, supply, installation testing and commissioning of complete ductwork system for air conditioning fresh air, exhaust and ventilation systems.

1.2 Scope of Work

1.2.1 The contractor shall be responsible for submitting complete above works based on design consultant's approval of submitted samples, documents etc as per specifications and applicable standards.

1.3 Related Works Specified Elsewhere

1.3.1 The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated herein verbatim.

Section 23 05 00	-	Common Works Results for HVAC
Section 23 07 00	-	HVAC Insulation
Section 23 09 00	-	Instrumentation And Controls for HVAC
Section 23 20 00	-	HVAC Piping and Pumps
Section 23 30 00	-	HVAC Air Distribution
Section 234000	-	HVAC Cleaning Devices
Section 23 70 00	-	Central HVAC Equipment
Section 238000	-	Decentralized HVAC Equipment
Division 25	-	Integrated Automation

1.4 Reference Standards

HVAC DW 144	Sheet Metal Ductwork
NFPA 90A	Standard for the installation of air conditioning and ventilation systems
SMACNA	Sheet Metal and air conditioning contractors national association
ASHRAE	American society of heating, refrigeration and air conditioning
UL 181	underwriters laboratories
ASTM A653-99	Specification for steel sheet, Zinc-coated (Galvnized) by Hot-Dip process

1.5 Ductwork Design Criteria

1.5.1 AU rectangular ducts shall be of the low pressure rating and all circular round ducts shall be of the high pressure rating.

1.5.2 Galvanized sheet steel shall be fabricated, erected and installed in accordance with NFPA 0A and "SMACNA" sheet metal manuals.

1.5.3 All rectangular metal ducts shall be sealed in accordance with ASHRAE Standard 90 and SMACNA low pressure duct construction standards. All high pressure ducts shall be air tight.

1.5.4 Kitchen exhaust ducts shall be constructed and installed in conformance with NFPA 96 and must: Be constructed from carbon steel (for concealed ducts) with a minimum thickness of 1.4 mm and from stainless steel (for exposed ducts) with a minimum thickness of 1.1 mm.

1.5.5 Stair case or lift well pressurization duct shall be fire rated.

1.5.6 Ducts that meant to be used for smoke exhaust shall be fire rated unless:-

1.5.7 It doesn't cross any other fire / smoke zones, i.e. its route within the same fire / smoke zone which it serves.

1.5.8 It is contained solely in a fire rated shaft and no other services included in the same shaft.

1.5.9 All return air ducts inlets shall be fitted with stainless steel wire mesh.

PART 2 PRODUCTS

2.1 Duct work

2.1.1 Galvanized sheet steel ducts shall be of G90 coating designation within ASTM A653-99, standard specification for 'steel sheet zinc coated by the hot dip process'. The weight of coating on both sides of duct shall be 0.9 oz/ft2 (275g/m2) as a minimum check limit triple spot test.

2.1.2 The ducts' gauges, thickness, type and method or jointing shall be as detailed and tabulated on the Drawings and/or in compliance with ASHRAE Standards and Handbooks.

2.1.3 Stainless steel ducts shall be of 316 for all Toxic exhaust air in accordance with ASTM Standards and Specifications.

2.2 Duct Hangers and Support

2.2.1 Supply and install steel work necessary for the support of the ductwork. Hangers shall be spaced not more than 3000 mm. apart, and at changes of direction. Types and construction of hangers shall be as detailed on the Drawings and in compliance with SMACNA recommendations.

2.3 Flexible Ducts

2.3. 1 Ducts shall be all metal constructed of heavy gauge corrugated aluminium with water tight continuous lock seams.

2.3. 2 Ducts shall be UL 181 Class O non-combustible and complying to NFPA 90A & 90B, or tested to BS 476 (parts 6, 7 & 20) class 1 flame spread and meets the requirements of CP 413 section A2.2.3.

2.3. 3 For air conditioning flexible ducts shall have 25mm thick fiber glass insulation and sheathed in durable polymer vapour barrier.

2.4 Fire Rated Ductwork

2.4.1 2. hours fire resisting ductwork shall be installed where indicated on the drawings or mentioned in Specifications or required by Local Authorities.

2.4.2 Provide complete 2 hours fire rated fire resistive enclosures for smoke and pressurization systems where ductwork is located outside fire rated shaft.

2.4.3 Fire resisting duct and smoke duct shall be manufactured erected and tested in accordance to BS 476 Part 24 ISO 6944.

2.4.4 Fire resisting duct shall prove by test that its cross section area is maintained above 75% when subject to full fire temperature.

2.4.5 Fire resisting duct shall be constructed and protected to insure maintaining the stability, integrity insulation supports, fixing throughout the required period.

2.4.6 Fire resistance filling (fire stopping material) shall seal the clearances between fire resisting duct and wall to insure the stability and integrity of the system.

2.4.7 Fire resisting duct shall be connected to fans by fire rated flexible connectors. Flexible connectors shall be made of glass fabric coated on both sides with flame retardant silver grey polyurethane rubber tested to BS476 Part 20.

2.4.8 All drop rods and exposed bearers shall be insulated in accordance to manufacturer’s instructions to assure its fire resistance.

PART 3 EXECUTIONS

3.1 Duct Construction

3.1.1 All ducts shall be constructed and erected so as to be rigid and free from sway, drumming and movement. Duct work shall be true to sizes indicated on Drawings, straight and smooth on the inside with neatly finished joints. Whenever internal acoustic lining is indicated on the Drawings, the duct sizes have to be increased to accommodate the lining.

3.1.2 Ductwork joints shall be square with all sharp edges removed.

3.1.3 The ducts shall be routed with a minimum of directional changes and abrupt transitions.

3.1.4 Adequate space shall be provided around ducts to assure proper support and to allow the installation of the specified insulation.

3.1.5 All connections between ductwork, including flexible connections, fittings and equipment, shall be made with gradually tapered transition fittings.

3.1.6 Whenever a flexible duct is used to correct misalignment between the supply duct and the diffuser ceiling location, the misalignment (or offset) shall not exceed one-eighth (1/8) the length of the collar (or diffuser diameter). Flexible duct length shall not exceed 30 cm.

3.1.7 Changes in section of ductwork shall be effected by tempering in ducts with as long a taper as possible. All branches shall be taken off at not more than 45 degree angle from the axis of the main duct unless otherwise approved by the Engineer.

3.1.8 The ducts shall be securely anchored to the building in an approved manner.

3.1.9 The ducts shall be installed as to be completely free from vibration under all conditions of operation.

3.1.10 The ducts and hangers shall be installed straight, plumb and level.

3.1.11 Wherever ducts pass thru walls or floors, a sleeve of galvanized mild steel sheet shall be provided and the space between the pre-insulated duct and the sleeve shall be caulked with lead wool and finished on each face with a mastic fill.

3.1.12 Flexible ducts should be kept as short as possible (maximum 30 cm) and fully extended. All slip joints shall be made in the direction of flow.

3.1.13 All elbows shall have a centre line radius equal to at least 1.5 times the width of the duct, otherwise turning vanes shall be installed in the elbows.

3.1.14 Adjustable splitters and hinged volume dampers shall be provided at every duct junction on both supply and exhaust ductwork for adjusting air volumes.

3.1.15 Where splitters and dampers are installed above suspended ceiling, flush-mounted controlling devices shall be used.

3.1.16 Connection to diffusers, grilles and registers shall be made absolutely airtight.

3.1.17 Equalizing grids or turning vanes shall be installed ahead of an air outlet whenever poor approach conditions, from the main duct to the outlet, exist.

3.1.18 In critical low noise level projects, poor approach conditions are not allowed. Where the duct is pierced for any reason, sealing compound shall be used. All joints and fittings concealed in vertical duct shafts shall be welded.

3.1.19 For duct work balancing and testing refer to Section 23 05 93 Subsections 1.3 and 1.4.

3.2 Protection and Cleaning

3.2.1 During construction, cover all open ends of ductwork with one layer of canvas.

3.2.2 Remove all foreign materials and clean the duct inside and outside.

3.2.3 Clean ducts before operating fans and filters. Never operate fans unless filters are installed.

3.2.4 Operate the fans and thoroughly blowout the interior surfaces of the duct work.

3.2.5 After tests, wash cleanable filters and replace renewable media.

3.3 Access Openings in Insulated Ducts

3.3.1 Where ducts require to be thermally insulated the door frame shall be extended beyond the face of the duct by a measurement equal to the thickness of the insulation and as arranged so that the insulation can be 'dressed' into the frame. Doors or covers shall be suitably insulated and provisions made to ensure that the seal is continuous across the whole opening. The extent of the opening shall be clearly visible or otherwise indicated. Where it is impossible to vapour seal an access opening, provision shall be made for collecting and draining condensation.

3.4 Approved List of Manufacturers

3.4.1 For accepted products, Manufacturers and suppliers, refer to Appendix A.

End of Section 23 31 00.

SECTION 23 33 00

AIR DUCTS ACCESSORIES

PART 1 GENERAL

1.1 Introduction

1.1.1 This section includes the design, supply, installation testing and commissioning of all materials for the complete installation of air distribution specialties and duct accessories for the air distribution system.

1.2 Scope of Work

1.2.1 The contractor shall be responsible for submitting complete above works based on design consultant's approval of submitted samples, documents etc as per specifications and applicable standards.

1.3 Related Works Specified Elsewhere

1.3.1 The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated herein verbatim.

Section 23 05 00 - Common Works Results for HVAC
Section 23 07 00 - HVAC Insulation
Section 23 09 00 - Instrumentation And Controls for HVAC
Section 23 20 00 - HVAC Piping and Pumps
Section 23 30 00 - HVAC Air Distribution
Section 234000 - HVAC Cleaning Devices
Section 23 70 00 - Central HVAC Equipment
Section 238000 - Decentralized HVAC Equipment
Division 25 - Integrated Automation

1.4 Reference Standards

UL 555	Standard for fire Dampers and ceiling dampers
NFPA 90A	Standard for installation of air conditioning and ventilating systems
ASTM-A525	Specification for general requirements for steel sheet, zinc-coated (galvanized), by the Hot-dip process.
BS 5588-Part 9	Code of Practice for air-conditioning and ventilation duct work

1.5 Fire Dampers - General Requirements

1.5.1 Fire dampers shall be provided on all duct branches which pierce fireproof floors, walls, shafts, ceilings and as required in accordance with NFPA SECTION NO. 90A.

1.5.2 Assemblies shall be complete with damper blades, fusible links, linkage and stops.

1.5.3 Dampers shall be proportioned and weighed to close at once if released from a link with spring catches and shall stay closed until manually reset.

1.5.4 Dampers and frames shall have suitable peep holes.

1.5.5 Fire damper installation shall guarantee the fire wall integrity.

1.6 Noise Attenuation

1.6.1 The Contractor shall supply and fix acoustic insulation and noise attenuator units where necessary and as shown on drawings and/or required by the Specialist study to reduce the air borne noise transmission through the distribution duct system, so that the specified noise criteria levels are satisfied.

PART 2 PRODUCTS

2.1 Volume Control Dampers

2.1.1 Volume control dampers shall be complete with locking levers and quadrants, indicating their position.

2.1.2 Volume dampers shall be provided whether shown/or not on drawings in main ducts, in all branch ducts supplying three (3) or more air outlets, in all fresh air intakes etc to achieve proper system balancing.

2.1.3 Volume control dampers shall be of the butterfly type for ducts 15" (380 mm) in depth and lower, and multiple opposed blade type for ducts above 15" (380 mm) in depth. Maximum blade size shall be 48" x 10" (1220 x 250 mm). For ducts larger than 48"(1220 mm), multiple frame sections shall be used. Blades shall not be less than 18 gauge. Duct shall be stiffened at damper location. Volume dampers for circular ducts shall be of the multiple opposed blade type fitted in a square section.

2.1.4 Upon completion of the ductwork, dampers shall be adjusted and set to deliver the amounts of air indicated on the Drawings.

2.2 Gravity Dampers

2.2.1 Gravity dampers shall consist of:

a. Galvanized sheet steel frame.
b. Aluminum blades.
c. Stainless steel bearing shafts and brass bearings.
d. Neoprene seal to withstand 120°C. air temperature.
e. Aluminum blade travel stop.

2.2.2 All blades shall be coupled together by means of an aluminum bar.

2.3 Fire Dampers (Curtain Type)

2.3.1 Each fire damper shall have a 2 hour fire protection rating and a 1650 F (73.9 °C) fusible link. Fire damper frame shall be constructed of 20 gauge galvanized steel channel. Blades shall be curtain type of 24 gauge galvanized steel and finish shall be mill galvanized to ASTM A525 g-60.

2.3.2 Each fire damper shall be constructed and tested in accordance with UL Safety Standard 555.

2.3.3 Fire dampers shall be equipped for vertical or horizontal installation. Horizontal mounted dampers shall be spring loaded.

2.3.4 All necessary accessories such as sleeves, angles etc. shall be provided for proper installation of fire damper as per manufacturer instructions and it shall finally guarantee the integrity of the fire wall.

2.4 Smoke Dampers

2.4.1 Furnish and install at all locations shown on plans, motorized dampers of the following specifications. Frame shall be minimum of 16 gage galvanized steel formed into a structural hat channel shape with tabbed comers for reinforcement. The blades shall be single skin 16 gage minimum galvanized with three longitudinal grooves for reinforcement. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Jamb seal shall be stainless steel flexible metal compression type.

2.4.2 Each damper shall be classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems. The leakage rating under UL555S shall be leakage Class III (40 cfm/ft.at 1" w.g.).

2.4.3 As part of the UL qualification, dampers shall have demonstrated a capacity to operate (to open and close) under HVAC system operating conditions with pressure of at least 4" w.g. in the closed position and 2000 fpm air velocity in the open position.

2.4.4 In addition to the leakage ratings already specified herein, the dampers and their actuators shall be rated for the elevated temperature anticipated by the smoke but not less than

572°F (300°C). Appropriate electric actuators shall be installed by the damper manufacturer at time of damper fabrication. Damper and actuator shall be supplied as a single entity which meets all applicable UL 555S qualifications for both dampers and actuators. Factory supplied caulked sleeve shall be 20 gage for dampers through 84" wide and 18 gage above 64" wide. Damper and actuator assembly shall be factory tested to assure operation. All wiring or piping material required to interconnect the actuator with detection and/or alarm or SMS system shall be furnished under fire alarm on BMS installation as applicable.

2.4.5 Blade Position Indicator:- Each smoke damper shall be equipped with two position indicator switches linked directly to the damper blade to provide the capability of remotely indicating damper blade position.

2.4.6 For Damper actuator, refer to Section 25 50 00.

2.5 Motorized Dampers

2.5.1 Motorized automatic dampers shall be of the louver type with not less than 13 gauge welded steel frames and galvanized finish. Blades shall have interlocking edges, stainless steel side springs (or vinyl or neoprene gaskets), and teflon-coated stainless steel thrust washers. Blades shall be edged with neoprene if the damper is to operate in outside air service either as an intake or discharge damper. Damper blades shall have steel trunnions mounted in nylon or oilite bearings.

2.5.2 Dampers shall be not more than 1200mm. in length between bearings. Modulating dampers shall be of the opposed blade type unless specified otherwise. Blades shall be not over 200mm. in width and shall not be less than 16 gauge galvanized steel. Hardware shall be zinc plated. One damper actuator shall be provided for each 1.5 sq. meter of damper area.

2.5.3 Provide parallel blade dampers arranged for maximum turbulence and mixing of outside air with return air. Arrange dampers as necessary to prevent stratification or provide baffles necessary to correct stratification problems.

2.5.4 Provide dampers of low leakage construction, so designed that the maximum leakage shall be 10 cfm/ft^2 (0.005 m3/s/m^2) of damper with 411WG. (1 Kpa) pressure differential applied.

2.5.5 For damper actuator specification, refer to Section 25 50 00.

2.6 Flexible Connections

2.6.1 Flexible connections of approved flame retardant fabric to prevent the transmission of vibration through the ducts shall be installed on both the supply and return sides of all fans and ventilating units for a maximum length of 250mm. and a minimum of 100mm. in the direction of the flow. The fabric shall have a flame spread rating of not over 25 and a smoke developed rating of not higher than 50.

2.6.2 Flexible connections shall connect ducts across structural expansion joints.

2.6.3 Cloth used for flexible connections shall be of proper weight and strength for the service required, and shall be properly fitted to render it relatively tight.

2.6.4 Neoprene laminated fabric, with neoprene facing on interior surface, shall be used for ducts handling other than clean dry air.

2.6.5 Flexible duct connection used for air conditioning, air handling units shall have vinyle coated fabric insulated with 111(25 mm) fiberglass insulation of 0.75 *Ibs/ft3* (12 *Kg/m3)* minimum density, designed to NFPA-90 or BS 5588 part 9 Standards. The connector should be pre-assembled metal to fabric.

2.6.6 The connector shall be 2.4 gauge galvanized zinc to ASTM-A525 G 60.

2.7 Belt Guards

2.7.1 Guards shall be provided for all belt-driven units.

2.7.2 Guards shall be made to enclose both pulleys and belts on exposed sides and shall be constructed of galvanized steel top and bottom with perforated or expanded metal front Pittsburgh-locked into the rim.

2.7.3 The entire assembly shall be rigidly supported.

2.7.4 Provision shall be made for accessibility of all points drilled to receive tachometer.

2.7.5 Provide coupling guards on direct-connected units.

2.7.6 Guards shall be designed for easy removal for service and shall comply with Underwriters' Safety Requirements.

PART 3 EXECUTION

3.1 Access Openings

3.1.1 General

3.1.1.1 Access doors shall be provided for volume damper quadrants installed in concealed spaces, for control valves, for fire dampers or as specified hereinafter.

3.1.1.2 All access openings shall be rigidly framed and made air-tight. Covers shall be simply and speedily removed and re-fixed. Multiple set screws or self-tapping screws will not be acceptable as a method of fixing. Access doors and other openings in ductwork shall be provided for the purposes given below. The number, size and locations shall be as indicated on the Drawings or as necessary to ensure adequate access to equipment and plant.

3.1.2 Access for Personnel

3.1.2.1 Access doors shall not be larger than 1350mm. high by 500mm. wide, unless essential for equipment handling. Doors shall open against the air pressure. Duct openings and the access doors shall be adequately reinforced to prevent distortion. Suitable sealing gaskets shall be provided together with sufficient clamping type latches to ensure air-tight and water-tight sealing between the door and the duct. All personnel access openings shall have latch handles on both the inside and outside of the door.

3.1.3 Access for Maintenance. Cleaning and Inspection

3.1.3.1 Inspection openings shall generally not be larger than 300mm high by 400mm. wide unless essential for access to equipment, in which case the size shall be agreed before manufacture. The opening in the duct shall be adequately stiffened and the door cover sufficiently rigid to prevent distortion. Approved sealing gaskets and suitable fastenings shall be provided to ensure air-tight sealing.

3.1.4 Test Holes for Test Equipment and Instruments

3.1.4.1 Test holes shall be provided wherever instructed by the engineer, and in all main ducts and branch ducts to correctly establish design air flows and to check the performance of fans and regulating dampers. All holes shall be 25mm. dia. and suitably strengthened. Cover plates shall be screw-fixed to the duct and sealed.

3.1.5 Access Openings in Insulated Ducts

3.1.5.1 Where ducts require to be thermally insulated the door frame shall be extended beyond the face of the duct by a measurement equal to the thickness of the insulation and as arranged so that the Insulation can be 'dressed' into the frame. Doors or covers shall be suitably insulated and provisions made to ensure that the seal is continuous across the whole opening. The extent of the opening shall be clearly visible or otherwise indicated. Where it is impossible to vapour seal an access opening, provision shall be made for collecting and draining condensation.

3.2 Approved List of Manufacturers:

3.2.1 For accepted products, Manufacturers and suppliers, refer to Appendix A.

End of Section 23 33 00

SECTION 23 34 00

HVAC FANS

PART 1 GENERAL

PART 2 PRODUCTS

SECTION 23 34 00

HVAC FANS

PART 1 GENERAL

1.1 Scope of Work

1.1.1 The works covered under this Section shall include all the supply, installation, testing and delivery in good operating conditions of a complete Ventilating system as described, shown detailed or implied in the tender documents of the project.

1.1.2 The Contractor shall provide all the necessary components and accessories as well as manpower, scaffolding, painting, testing facilities, etc ... at his own expense to execute a complete operable system.

1.1.3 The Contractor shall program his work such that it will not interfere with other trades and to suit site requirements.

1.2 Related Works Specified Elsewhere

1.2.1 The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated herein *verbatim.*

Section 23 05 00 - Common Works Results for HVAC
Section 23 07 00 - HVAC Insulation
Section 23 0900 - Instrumentation And Controls for HVAC
Section 23 20 00 - HVAC Piping and Pumps
Section 23 30 00 - HVAC Air Distribution
Section 234000 - HVAC Cleaning *Devices*
Section 237000 - Central HVAC Equipment
Section 23 80 00 - Decentralized HVAC Equipment
Division 25 - Integrated Automation

1.3 Codes and Standards

1.3.1 Codes and standards applicable to this section shall be primarily British Standards and United States Codes, unless otherwise specified, the performance/manufacturing standards of items mentioned in this section shall confirm to the applicable portions of the latest editions of the following codes, standards and regulations.

Reference Code	Abbreviation	Applicable Standard	Title of Standard
American Society of Heating Refrigeration and Air Conditioning	ASHRAE	-	-
National Electrical Manufacturers Association	NEMA	-	-
National Electrical Code	NEC	Section 424	-
Air Moving and Conditioning Association	AMCA	-	-

National Fire Protection Association	NFPA	NFPA 90A	Standard for Air Coditioning and Ventilation Systems
Underwriters Laboratories	UL	UL181	-
American Standards for Testing and Materials	ASTM	ASTM A525-75	Specification for general requirements for steel, Zinc-coated(galvanized) by the hot-dip process

1.4 General Requirements for Ventilating Fans

1.4.1 The fan motors and starters shall be in accordance with the Electrical division of these specifications.

1.4.2 Test and rate all fans in accordance with the standards of the AMCA. All fans must bear the AMCA certified rating seal.

1.4.3 Make appropriate allowance for the effects on fan performance of all installation conditions including plenum enclosures and inlet and discharge arrangements so that actual installed fan performance equals that specified.

1.4.4 Balance all fan wheels and all other moving components statically and dynamically. Where coating is specified and it affects the balance of the fan wheel, perform balancing after the coating has been applied.

1.4.5 Drill all fan shafts on the center line to receive a tachometer.

1.4.6 Belt driven fans shall be connected to the driving motor by means of an approved V-belt drive, with adjustable sheaves, unless otherwise designated. V-belt drives shall be designed for 50% overload capacity and the motors for such drives shall be equipped with adjustable bases or slide rails.

1.4.7 Bearings shall be self-aligning, grease lubricated, ball-bearing type, and shall be complete with grease fittings, extended for easy access where necessary.

1.4.8 Weather proof hoods should be provided for all motors and drives exposed to weather to the approval of the Engineer.

1.4.9 Back draft dampers, gravity type, shall be installed on the fan discharge of all fans discharging directly to the atmosphere except the kitchen hood fan.

1.4.10 Fans scheduled for the exhaust of kitchen equipment. hoods and high temperature exhaust systems shall include an up blast arrangement on the discharge with complete grease drainage and insulated heat shield to protect motor and drive, all designed for high temperature services.

1.4.11 Fans are to operate steadily without pulsation at design conditions. Centrifugal fan characteristic curves must be such that the fan operating point falls below the point of no flow static pressure, to the right of the point corresponding to that of maximum mechanical efficiency, and a 15% increase in static pressure over that specified results in not more than a 15% reduction in cfm and does not affect the stability of fan operation. If necessary accomplish the foregoing by modifying the width of the wheel and/or by providing inlet vanes to change the characteristic curve.

1.4.12 Performance curves shall be submitted for each fan for approval.

1.4.13 Fans power shall not exceed 2.8 Watt/Lit/Sec. or as requested by LEED/GREEN requirements.

PART 2 PRODUCTS

2.1 Centrifugal In-Line Fan (Smoke/Fume Fans)

2.1.1 Fan shall be of the centrifugal in-line type steel construction and shall be complete with:

a. Electric motor mounted outside the air stream.
b. Metallic fixing frame and supports.
c. Dust proof, non fused disconnect switch under motor casing.
d. Belt drive and belt guard.
e. Vibration isolators.
f. All aluminium centrifugal backward inclined blades impeller with non overloading horse power characteristic.
g. Flexible duct connection at each end.
h. Fans used for smoke exhaust shall have all welded housing with motors and all parts rated for the high temperature anticipated by the smoke, but not less than 752°F (400°C).
i. Electric meter shall be of variable speeds if shown in capacity schedule.

2.1.2 Fans shall be supplied complete with minimum IP55 sheet steel control panel. The panel shall include but shall not be limited to the following:-

a. Door interlocked disconnect switch.
b. Duty alternator (where needed)
c. Circuit breaker.
d. Motor starters
e. On/Off/Auto with pilot light
f. Control power transformer
g. Control wiring
h. Volt free contacts for connection to BMS
i. Single phasing protection

2.1.3 Fans shall be coated at the factory with anti corrosion coating as recommended by the manufacturer.

2.2 Centrifugal In-Line Fan (Up to 500 cfm)

2.2.1 Fan shall be constructed of steel with epoxy finish highly resistant against atmospheric agents. Fan shall have back inclined impeller fixed and balanced directly on the motor. Electrical connections shall be enclosed in a plastic box with IP54 protection. All fans exhausting air from the dryer shall be rated for 60 degree C air temperature.

2.3 Centrifugal Single Inlet Fans (Staircase I Lift Well Pressurization)

2.3.1 Pressurization fan shall be of the centrifugal single inlet backward curved blades type with two-piece housing where wheel, shaft and inlet pan assembly installed in lower housing section. Average life of fan bearing shall not be less than 200,000 hours. Fan shall be complete with:

a. Electric motor mounted on one chassis with the fan.
b. Reinforced heavy gauge fan casing.
c. Metallic fixing frame and supports.
d. Dust proof, non-fused disconnect switch.

e. Pulleys, belt drive and belt guard.
f. Spring vibration isolators.
g. Heavy flanges on both sections of housing for assembly. Flanged joints shall be gasketed for air tightness.
h. Galvanized steel mesh screen.
i. Non-return damper
j. Fans shall be supplied complete with minimum IP55 sheet steel Control Panel (CP) as indicated in Electrical Drawings. The panel shall include but shall not be limited to the following:-

- Door interlocked disconnect switch
- Duty alternator (where needed)
- Circuit breaker
- Motor starters
- On/Off/Auto with pilot light
- Control power transformer
- Control wiring
- Volt free contacts for connection to BMS
- Single phasing protection.

2.3.2 Fans shall be coated at the factory with anti corrosion coating as recommended by the manufacturer, for outdoor use in high temperature and humid atmosphere.

2.3.3 Fans shall be interlocked with fire alarm panel to be activated in case of fire in any particular zone.

2.4 Vane Axial Fans

2.4.1 Each fan shall be of the axial type with belt driven aerofoil impeller. Casing shall be fabricated from mild steel hot dipped galvanized after manufacture.

2.4.2 Each fan shall be complete with:

- Electric motor mounted on fan casing.
- Sealed ball bearings

- V-belt with bullies keyed to the shaft.
- Belt tuner and screen.
- Integral guide vanes.
- Protection ground.
- All parts of Fan used for smoke exhaust shall be rated for the high temperature
- anticipated by the smoke, but not less Thant 752 of (400°C).

2.5 Wall Propeller Exhaust Fan

2.5.1 Wall exhaust fan shall be of the wall or window mounted type all plastic construction. Fan shall be complete with outside plastic grille, enough length of electrical flexible cord (including ground conductor) with suitable connecting end (plug, or ..) to connect to electrical outlet, and wall mounted on-off switch. Fan shall have a shutter that opens and closes automatically by means of an electromagnet.

2.6 Exhaust Fan

2.6.1 Shall be of the centrifugal single inlet backward curved blades type with two-piece housing where wheel, shaft and inlet pan assembly installed in lower housing section. Fan shall be complete with:

2.6.1.1.1 Electric motor mounted on one chassis with the fan.

2.6.1.1.2 Reinforced heavy gauge fan casing.

2.6.1.1.3 Metallic fixing frame and supports.

2.6.1.1.4 Dust proof, non-fused disconnect switch.

2.6.1.1.5 Pulleys, belt drive and belt guard.

2.6.1.1.6 Vibration isolators.

2.6.1.1.7 Heavy flanges on both sections of housing for assembly. Flanged joints shall be gasketed for air tightness.

2.7 Centrifugal In-Line Fan (Not for Smoke)

2.7.1 Fan shall be of the centrifugal in-line type all aluminium construction and shall be complete with:

2.7.1.1 Electric motor mounted outside the air stream, when air temperature inside the duct is above 200 of (93°C), otherwise inside air stream.

2.7.1.2 Metallic fixing frame and supports.

2.7.1.3 Dust proof, non fused disconnect switch under motor casing.
2.7.1.4 Belt drive and belt guard or as stated in Capacity Schedule.
2.7.1.5 Vibration isolators.
2.7.1.6 Aluminium air foil blades impeller with non overload.ing horse power characteristic.

2.7.1.7 Flexible duct connection at each end.

2.8 Roof Ventilators

2.8.1 Each roof ventilator shall be of the centrifugal vertical discharge type coupled through a belt drive to its electric drive motor suitable for roof mounting and outdoor operation.

2.8.2 Each roof ventilator shall be complete with:

2.8.2.1 Electric motor suitable for outdoor operation.

2.8.2.2 Aluminium protective cowl and body
.
2.8.2.3 Metallic fixing and supporting frame.

2.8.2.4 Weather proof non fused disconnect switch under fan cowl.

2.8.2.5 Galvanized steel bird screen.

2.8.2.6 Automatic shutter

2.9 Centrifugal Exhaust Ventilator (Roof Or Wall Mounted)

2.9.1 Fan to be spun Aluminium centrifugal exhauster belt or direct, driven, down blast or horizontal discharge and shall be wall or roof mounted as applicable and shown on drawings. Fan shall be UL listed and shall bear the AMCA certified ratings seal for sound and air performance.

2.9.2 The fan shall be bolted and welded construction utilizing corrosion resistant fasteners spun Aluminium structure shall be minimum 16 gauge marine alloy Aluminium. The motor, bearings and drives shall be mounted on a minimum 14 gauge steel power assembly with vibration isolation, these components shall be enclosed in a weather tight compartment separated from airstream. Wheels shall be centrifugal backward inclined, constructed of 100% Aluminium, wheel vanes shall be welded to the inlet cone to ensure permanent wheel stability and alignment, wheels shall be balanced in accordance with AMCA standard 204-96.

2.9.3 Bearings shall be heavy duty with average life of 200,000 hours. Belts shall be of oil and heat resistant, non-static type. Drives shall be machined cast iron sized up to 150% of installed motor HP. Variable pitch motor drive must be factory set to the specified fan rpm.

2.9.4 Each fan shall be complete with:-

2.9.4.1 Heavy duty electric motor suitable for outdoor operation with permanent lubrication.

2.9.4.2 Aluminium protective cowl and body.

2.9.4.3 Metallic fixing and support.ing frame.

2.9.4.4 Weatherproof non fused disconnect switch under fan cowl.

2.9.4.5 Galvanized steel bird screen.

2.9.4.6 Automatic shutter

2.9.4.7 Control panel.

2.10 Ceiling Mounted Exhaust Fan

2.10.1 Ceiling exhaust fan shall be of the centrifugal double inlet fan with bottom intake through an extruded aluminium grille, and horizontal ducted discharge. Casing shall be of rigid formed steel housing with baked enamel finish. Unit shall be complete with:

2.10.1.1 Motor with vibration isolators.

2.10.1.2 Enough length of electrical flexible cord with disconnect plug and integral electrical knockouts, accessible from outside ..

2.10.1.3 Shutter which closes automatically by means of an electromagnet when the exhaust fan is off.

2.11 Belt Driven Wall Exhaust Fans

2.11.1 Fan shall be of the propeller, wall mounted, belt drive type.

2.11.2 Fan shall be supplied complete with the following:

2.11.2.1 Totally enclosed electric motor complete with cast aluminium drive assembly.

2.11.2.2 Cast aluminium bladed propeller with separate blades mounted in a cast aluminium hub, propeller shall be statically and dynamically balanced.

2.11.2.3 Removable polyvinyl coated screen at inlet side.

2.11.2.4 Sealed ball bearings.

2.11.2.5 Motorized aluminium damper at outlet.

2.11.2.6 Aluminium casing with adjustable anchor angle and aluminium frame.

2.12 Fresh Air Fans

2.12.1 Fan shall be of the centrifugal double inlet width, backward curved blades type with non- overloading design wheel diameters and outlets areas shall be in accordance with the standard sizes adopted by the AMCA for non-overloading fans. Inlets shall be fully stream lined and housing shall be suitably braced to prevent vibration or pulsation.

2.12.2 Fan shall be supplied complete with:

2.12.2.1 Electric motor mounted on one chassis with the fan.

2.12.2.2 Reinforced heavy gauge fan casing.

2.12.2.3 Metallic fixing frame and supports.

2.12.2.4 Pulleys, belt drive and belt guard (of expanded metal with tachometer hole).

2.12.2.5 Vibration isolators.

2.12.2.6 Fan wheels with die formed backward curved blades designed for maximum efficiency and quiet operations. Wheels shall be statically and dynamically balanced.

2.12.2.7 Heavy flanges on both sides of housing. Flanged joints shall be gasketed for air tightness.

2.12.2.8 Fan inertia should be checked against motor capability. If fan inertia is found larger, then a centrifugal or plate clutching service should be used to enable the fan to be brought up to speed without damaging the motor.

2.12.2.9 Motorized damper at fan outlet to open and close with fan on/off operation.

2.13 Spare Parts

2.13.1 The Contractor shall provide as part of his contract a list of spare parts for all the equipment supplied sufficient for three years of operation all in accordance with the recommendationsof the manufacturers of the equipment.

2.14 Special Tools

2.14.1 A complete set of special tools, oil and grease for all the plant and equipment supplied, adequate for 12 months operation shall be supplied by the Contractor at the completion date of the project.

2.15 Operation and Maintenance Manuals

2.15.1 The Contractor shall furnish and submit to the Engineer in triplicate bound, A4 size, Instruction Manuals containing the following material:-

2.15.1.1 Brief description of each system and its service and basic operation features.

2.15.1.2 Manufacturer's mechanical equipment parts list of all functional components of the systems listed on the Drawings, control diagrams and wiring diagrams of controllers. List shall give system No., unit no., Manufacturer's Model No., and Manufacture's Drawing no. Parts list shall include manufacturer's recommended spare parts for one year operation.

2.15.1.3 Maintenance instructions for each type of equipment.

2.15.1.4 Possible breakdowns and repairs for each type of equipment. List of nearest local suppliers for all equipment.

2.15.1.5 Manufacturer's literature describing each piece of equipment control diagrams and wiring diagrams of controllers.

2.15.1.6 Complete, as installed, colour coded wiring diagrams of all electrical motor controller connections and interlock connections of other mechanical equipment.

2.15.1.7 The Contractor shall furnish all the foregoing to the Engineer for his review as to the fulfillment of the specified requirements.

2.15.1.8 All items shall be available at least four weeks prior to the substantial completion date.

2.16 Guarantee and Warranted Period

2.16.1 All equipment and accessories supplied by the nominated Sub-Contractor under this contract shall be guaranteed for a minimum period of one year from the date of final completion certificate.

2.16.2 All guarantee shall be unconditional. In the event of breakdown, the Contractor shall immediately provide and install a replacement unit of equal or superior performance until such time as the original unit is repaired. Failure by the Contractor to comply within 6 hours of notification, will entitle the Employer to purchase or hire a replacement and seek reimbursement from the Contractor for all related disbursements.

2.16.3 The Contractor shall guarantee every piece of equipment from any manufacturing or installation defects for a period of one year, starting from the date of issue of the substantial completion certificate.

2.17 Approved List of Manufacturers

2.17.1 For acceptable Products, Manufacturers and Suppliers, refer to Appendix A.

<u>End of Section 23 34 00.</u>

SECTION 23 36 00

AIR TERMINAL UNITS

SECTION 23 36 00

AIR TERMINAL UNITS

PART 1 GENERAL

1.1 Scope of Work

1.1.1 Works of this section shall be governed by Contract Conditions requirements.

1.1.2 Variable Air Volume (VAV) Units shall be as per the capacities shown on drawings and/or indicated in Bill of Quantities. Special attention should be made for the upper & downstream pressure when selecting the VAV.

1.2 Related Works Specified Elsewhere

1.2.1 The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated herein verbatim.

Section 23 05 00 - Common Works Results for HVAC
Section 23 07 00 - HVAC Insulation
Section 23 09 00 - Instrumentation And Controls for HVAC
Section 23 2000 - HVAC Piping and Pumps
Section 23 30 00 - HVAC Air Distribution
Section 234000 - HVAC Cleaning Devices
Section 23 70 00 - Central HVAC Equipment
Section 23 80 00 - Decentralized HVAC Equipment
Division 25 - Integrated Autoation

2 PRODUCTS

2.1 Constant Air Volume Terminal Units (CAV)

2.1.1 Supply and install CAV terminal units, of the same construction and insulation as the variable air volume (Pressure Independent) type terminal units.

2.1.2 The units shall have multi-leaf opposed blade dampers with neoprene seal and external linkage flange connected.

2.2 Variable Air Volume Terminal Units (Bypass Type)

2.2.1 Supply and install VAV terminal units of the by-pass type wherever shown on the drawings and of sizes and capacities as indicated there upon. Each terminal unit shall be electrically controlled and shall be supplied complete with:

2.2.1.1 <u>GENERAL</u>

2.2.1.1.1 Casing shall be welded 22-gauge galvanized steel with hanger holes at the four corners. Maximum casing leak rate shall not exceed 4% of nominal rating at 0.50 inches w.g. Unit shall have one round primary air inlet, one rectangular discharge outlet to the room and one round bypass discharge outlet.

2.2.1.1.2 Insulation-Interior surface of unit casing shall be acoustically and thermally lined with ½ inch, 1.9 Ib/cu. ft. density glass fiber with high density facing. Insulation shall be UL listed and meets NFPA 90A and

UL 181.

2.2.1.1.3 Bypass Balancing Damper - A field adjustable balancing damper shall be provided on the bypass outlet.

2.2.1.1.4 Discharge Duct Connection - Straight flanged rectangular discharge duct connection.

2.2.1.1.5

2.2.1.2 Electronic Controls

2.2.1.2.1 Electric Air Valves - Two, cylindrical airflow control devices, each with an integral 24 VAC electric actuator. The air valves modulate to provide variable airflow to the room in response to the room thermostat while maintaining constant primary unit airflow at unit inlet. Includes an eight-point, averaging flow sensing ring for airflow measurement to within 5% pf rated unit airflow, with 1 ½ diameters of straight upstream ductwork. Integral flow taps and calibration chart shall be provided on each unit. Leakage rate shall be less than 1% of nominal unit cfm at four inches inlet static pressure. Unit mounted potentiometers shall be provided for field adjustment of minimum and maximum airflow settings.

2.2.1.3 <u>Thermostat</u>

2.2.1.3.1 A remote room type thermostat shall be installed wherever shown on the Drawings. The thermostat shall be field wired to the circuit board.

2.3 Spare Parts

2.3.1 The Contractor shall provide as part of his contract a list of spare parts for all the equipment supplied sufficient for three years of operation all in accordance with the recommendationsof the manufacturers of the equipment.

2.4 Special Tools

2.4.1 A complete set of special tools, oil and grease for all the plant and equipment supplied, adequate for 12 months operation shall be supplied by the Contractor at the completion date of the project.

2.5 Operation and Maintenance Manuals

2.5.1 The Contractor shall furnish and submit to the Engineer in triplicate bound, A4 size, Instruction Manuals containing the following material:-

2.5.1.1 Brief description of each system and its service and basic operation features.

2.5.1.2 Manufacturer's mechanical equipment parts list of all functional components of the systems listed on the Drawings, control diagrams and wiring diagrams of controllers. List shall give system No., unit no., Manufacturer's Model No., and Manufacture's Drawing no. Parts list shall include manufacturer's recommended spare parts for one year operation.

2.5.1.3 Maintenance instructions for each type of equipment.

2.5.1.4 Possible breakdowns and repairs for each type of equipment.

2.5.1.5 List of nearest local suppliers for all equipment.

2.5.1.6 Manufacturer's literature describing each piece of equipment control diagrams and wiring diagrams of controllers.

2.5.1.7 Complete, as installed, colour coded wiring diagrams of all electrical motor controller connections and interlock connections of other mechanical equipment.

2.5.1.8 The Contractor shall furnish all the foregoing to the Engineer for his review as to the fulfillment of the specified requirements.

2.5.1.9 All items shall be available at least four weeks prior to the substantial completion date.

2.6 Guarantee and Warrantee Period

2.6.1 All equipment and accessories supplied by the nominated Sub-Contractor under this contract shall be guaranteed for a minimum period of one year from the date of final completion certificate.

2.6.2 All guarantee shall be unconditional. In the event of breakdown, the Contractor shall immediately provide and install a replacement unit of equal or superior performance until such time as the original unit is repaired. Failure by the Contractor to comply within 6 hours of notification, will entitle the Employer to purchase or hire a replacement and seek reimbursement from the Contractor for all related disbursements.

2.6.3 The Contractor shall guarantee every piece of equipment from any manufacturing or installation defects for a period of one year, starting from the date of issue of the Substantial completion certificate.

2.6.4 The Contractor shall issue a letter of guarantee for every compressor installed under his contract for a period of five years, starting from the date of issue of the substantial completion certificate. Contractor shall replace the defective compressor by a new one and shall submit a report to the Engineer explaining the reason of damage and methods to cure it.

2.7 Approved List of Manufacturers

2.7.1 For acceptable Products, Manufacturers and Suppliers, refer to Appendix A.

PART 3 EXECUTION (NOT USED)

End of Section 23 36 00.

SECTION 23 37 00

AIR OUTLETS AND INLETS

SECTION 23 37 00

AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 Introduction

1.1.1 This section of specification includes the design, supply, installation testing and commissioning of the Air inlets and outlets for the complete air conditioning and ventilating system including fresh air intakes, louvers, grilles, diffusers etc.

1.2 Scope of Work

1.2.1 The contractor shall be responsible for submitting complete above works based on design consultant's approval of samples, submitted documents etc as per specifications and applicable standards.

1.3 Related Works Specified Elsewhere

1.3.1 The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated herein verbatim.

Section 23 05 00 - Common Works Results for HVAC
Section 23 07 00 - HVAC Insulation
Section 23 09 00 - Instrumentation And Controls for HVAC
Section 23 20 00 - HVAC Piping and Pumps
Section 23 30 00 - HVAC Air Distribution
Section 23 40 00 - HVAC Cleaning Devices
Section 23 7000 - Central HVAC Equipment
Section 23 80 00 - Decentralized HVAC Equipment
Division 25 - Integrated Automation

1.4 Reference Standards

DW 142	British Heating and Ventilating Contractors Association Code of Practice
NP 90A	Standard for the installation of Air Conditioning and Ventilating Systems
ADC	Air Diffusion Council

1.5 Air Distribution Outlets General Requirements

1.5.1 All air outlets shall be of, at least the sizes indicated on the Drawings. Irrespective of the sizes indicated on drawings, diffusers/grillers shall be sized such that the noise spectrum of the supply outlets not higher than NC-25 but in all cases outlet selected shall perform within the noise level requirement of the space it is supplying. Outlets shall be supplied with foam rubber gaskets to prevent air leakage.

1.5.2 Where supply or return outlets are installed in continuous line, omit intermediate frames and margins. Provide guides for each element to keep adjoining lengths aligned and butted without breaks. All outlets shall be constructed of aluminum of the color specified or as selected by the

Engineer.

1.5.3 Outlets causing excessive air movement, drafts or objectionable noise shall be replaced at no cost to the owner.

1.5.4 All outlets shall be powder coated, samples showing finish and color shall be submitted to the Engineer for approval prior to supplying the outlets to Site.

1.5.5 The Contractor shall provide in his Tender for delaying the fixing of loose grilles until all other trades have completed their work, returning to the Site to fit the grilles as and when required to do so.

PART 2 PRODUCTS

2.1 Square - Air Diffusers

2.1.1 Air diffusers shall be of the diffusion and air mixing type and shall be made of anodized aluminum.

2.1.2 Supplied air shall be diffused with no air velocities in excess of 50 fpm. (0.25 *m/s)* at 1800 mm height or less above the floor line. Room air shall be mixed with the primary air by induction to effect subsequent uniformity of the room temperature without stratification.

2.1.3 Each diffuser shall be provided with an aluminum opposed blade damper.

2.1.4 Diffuser shall not project appreciably below ceiling or duct.

2.1.5 The inner assembly of the diffusers shall be attached to the outer assembly by means of a lock permitting assembly and disassembly without the use of tools.

2.1.6 The noise level shall be measured at a point one meter below the diffuser.

2.2 Linear Diffusers

2.2.1 Continuous slim line diffusers shall have extruded white anodized aluminum vanes and frames, unless otherwise indicated on the Drawings, and shall be designed for surface mounting on wall, ceiling or sill.

2.2.2 Diffusers shall be capable of diffusing air in a horizontal or vertical plane, combining discharge air diffusion, 20% aspiration and secondary air motion causing the discharge air to be diffused in such a manner that the air is delivered in a multiplicity of high and low pressure air currents causing turbulent air motion and insuring complete coverage and temperature uniformity within the space served.

2.2.3 The diffuser shall be provided with equalizing deflector and damper to accomplish uniform distribution throughout the length of the outlet.

2.2.4 The noise level shall be measured at a point 1800 mm below on either side of the diffuser.

2.3 Linear Bar Grilles

2.3.1 Linear grille shall have extruded polyester powder coated aluminum fixed bar and frames, unless otherwise indicated on the drawings and shall be designed for surface mounting.

2.3.2 Grilles shall be capable of diffusing air in a horizontal or vertical plane with 0° to 15° or 30° deflection. Air shall be diffused in such a manner that the air is delivered in a multiplicity of high and low pressure air currents causing turbulent air motion and insuring complete coverage and temperature uniformity within the space served.

2.3.3 The grille shall be provided with directional blades and damper to accomplish uniform distribution throughout the length of the outlet. All deflection bars shall be securely fixed and shall be parallel to the long dimension.

2.3.4 The noise level shall be measured at a point 1800 mm below on either side of the diffuser.

2.4 Grilles and Registers

2.4.1 All grilles shall be mounted upon substantial frames connected to the duct work, and shall be provided with soft plastic mounting rings inserted under the frame, so as to obviate leaks behind the grille.

2.4.2 All supply grilles and high level return grilles shall be double deflection, with horizontal face blade in the front, with airfoil blade construction, with minimum of 19 mm flange with gasket.

2.4.3 Supply registers shall be double deflection, horizontal face bars, airfoil blade construction, with aluminum opposed blade, key operated volume dampers, and 19 mm minimum gasket flange.

2.4.4 Return grille at low levels and fresh air grilles shall be single deflection fixed blade type with 19mm. flange with gasket where the sheet metal is visible behind the grille, paint the interior surface of the sheet metal flat black.

2.5 Fresh Air and Discharge Louvers

2.5.1 Louvers for fresh air intake, and for exhaust. They shall be white anodized aluminum.

2.5.2 Louvers shall be weatherproof, with fixed blades set at 30 degree and shall have a free area of 85%.

2.5.3 Louvers shall be furnished with ½" (13mm) mesh-bird screen secured in removable extruded Aluminum frames.

2.6 Sand Trap Louvers

2.6.1 Sand trap louver shall have a high degree of separation of sand and large dust particles, even in cases of high dust concentrations. The vertically arranged sections and holes for sand drainage shall ensure the sand trap louver is self-cleaning and maintenance free. The sand trap louver shall be designed to separate large particles at low air velocities, thus avoiding excessive dust loading.

2.6.2 The sand trap louver shall be constructed in polyester powder coated aluminum, and shall be complete with transom, sand chute and galvanized bird screen. Color shall be to Engineer's approval.

2.6.3 Whether shown on drawings or not, all fresh air intakes shall be with sand trap louvers, filters and volume control dampers.

2.7 Door Louvers

2.7.1 The door louvers shall be sized so that the face velocity does not exceed 250 fpm (1.3 *m/s)* unless otherwise indicated on the Drawings.

2.7.2 The louver shall be extruded aluminum completely lightproof V-Section with double frame.

2.8 DRUM TYPE LOUVRES

2.8.1 Drum type louvers shall be fabricated of extruded aluminium sections with felt seal around the rotating drum to prevent air leakage. Louvres shall have satin anodized aluminium finish.

2.8.2 The louver shall be adjustable to direct the air stream at any angle up to 30 ° from the louvres centerlines either by rotating the drum or by adjusting the position of the pivoted vanes.

PART 3 EXECUTION

3.1 Installation

3.1.1 All outlets shall be erected, leveled and accurately set in position, to ensure symmetry with other grilles, light fittings, etc. It has been arranged that final minor adjustments to suspension levels to obtain final accurate alignment between the ceiling and light fittings, diffusers, etc., shall be executed by those responsible for erecting the false ceilings.

3.2 Fixing

3.2.1 All outlets shall be concealed fixing type with no screws.

3.3 Rejected

3.3.1 Any imperfect outlet scratched or damaged surfaces of fixing screws having damaged heads, or scratched plating, will be rejected and shall be replaced satisfactorily before the Contract Works will be taken over as complete.

3.4 Approved List of Manufacturers:

3.4.1 3.4.1For accepted products, Manufacturers and suppliers, refer to Appendix A.

End of Section 23 37 00.

SECTION 23 40 00

AIR CLEANING DEVICES

SECTION23 40 00

AIR CLEANING DEVICES

PART 1 GENERAL

1.1 Introduction

1.1.1 This section includes the design, supply, installation, testing and commissioning of complete air cleaning devices for air conditioning systems.

1.2 Scope of Work

1.2.1 The contractor shall be responsible for submitting complete above works based on design consultant's approval of submitted samples, documents etc as per specifications and applicable standards.

1.3 Related Works Specified Elsewhere

1.3.1 The works specified in the following sections are included in this Section in each applicable part, as if repeated herein verbatim.

Section 23 05 00 - Common Works Results for HVAC
Section 23 07 00 - HVAC Insulation
Section 23 09 00 - Instrumentation and control for HVAC
Section 23 30 00 - HVAC Air Distribution
Section 23 50 00 - Central Heating Equipment
Section 2360 00 - Central Cooling Equipment
Section 23 70 00 - Central HVAC Equipment
Section 23 80 00 - Decentralized HVAC Equipment
Division 25 - Integrated Automation

1.4 Reference Standards

1.5 General Requirements

1.5.1 Provide temporary filter elements in the filter banks of supply systems used during construction prior to using the system.

1.5.2 Temporary filter elements shall be throw-away type with frames taped air-tight.

1.5.3 Immediately prior to test and balance operations, replace temporary filters with a new set of specified filter elements.

1.5.4 After final acceptance, a new set of filter elements shall either be delivered to owner or installed to replace 'Test" filters, as directed by Owner. Provide throw-away filters of thickness to fit frames of unitary equipment.

PART 2 PRODUCTS

2.1 FILTER ELEMENTS

2.1.1 Throw-away Filter

2.1.1.1 Throw-away filters - 2" (50 mm) thick fiberglass media contained in rigid frame with a supporting maze across both entering and leaving faces of Media. Minimum average 10% NBS efficiency with atmospheric dust. Maximum 0.1 7" WG. (42 pa) initial resistance at 500 FPM (2.5 *m/s) face* velocity.

2.1.1.2 Provide throw-away filters of thickness to fit frames of unitary equipment.

2.1.2 Bag Filter

2.1.2.1 Bag type filters shall be supported on substantial wire mesh frames fixed in a housing assembly containing the filter bags. The housing frames shall be drilled for assembly into a multiple battery suitable for mounting directly onto the downstream side of the outdoor louvers or grilles ..

2.1.2.2 Each bag is made up from three distinct layers of filter media. The first layer should provide dust holding capacity for long life, the second fine filtration of smaller particles and the third prevent fiber migration.

2.1.2.3 Bag filters shall have an initial clean filter resistance to air-flow not exceeding 0.28" WG. (70 pa) and a final resistance (dirty) not exceeding OS WG. (12S pa). The first layer shalt be of graduated density continuous filament glass, the second layer shall consist of the fiberglass or synthetic media, while the third layer shall consist of spun nylon backing.

2.1.3 Grease Filters

2.1.3.1 Grease filters- 2"(50mm) thick, constructed of cross-pleated layers of fine mesh aluminum media with aluminum frame. Filter shall be the high capacity, low resistance type which can be cleaned in hot water with a household detergent maximum initial resistance shall be 0.111wg(25pa) at a rated face velocity of SODFPM (2.S *m/s).*

2.1.4 Cleanable Filter

2.1.4.1 Cleanable filter: 2" (50mm) thick aluminum media, contained in aluminum frame. Filter shall have an average efficiency of 60 %, and it shall be capable of being completely cleaned by flushing with tap water. Holding frames shall be provided with polyurethane seals and stainless steel spring latches.

2.1.5 Framing System:

2.1.5.1 The filter bank framing shall be made from extruded aluminium framing members having a minimum thickness of 0.09" All members shall be cut to size and pre-punched for easy assembly into modules of the size and capacity required.

2.1.5.2 The framing member shall be permanently gasketed to prevent the bypass of unfiltered air. Vertical support members shall be provided if required to prevent deflection of horizontal member, and shall not interfere with the installation or the operation of the filter. The extruded members shall incorporate a separate track for pre-filters .. All filters shall be held in place with necessary fasteners which can be installed without the use of tools. A factory installed positive sealing device for each row of filters shall be incorporated in the framing system. Framing system modules shall be supplied complete with all necessary accessories for field assembly.

2.2 Approved list of Manufacturers

2.2.1 For acceptable Products, Manufacturers and Suppliers, refer to Appendix A.

End of Section 2340_00.

SECTION 23 81 00

DECENTRALIZED HVAC EQUIPMENT

SECTION 2381 00

DECENTRALIZ.ED HVAC EQUIPMENT

PART 1 GENERAL

1.1 Scope of Work

1.1.1 Units shall be completely packaged, factory assembled and factory charged, designed for such Applications.

1.1.2 Each Unit shall have multiple refrigeration systems for efficient full and part load operation as shown in the capacity schedules.

1.1.3 OX-Air conditioning unit shall have a minimum seasonal average COP of 3.4.

1.2 Related Works Specified Elsewhere

1.2.1 The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated herein verbatim.

Section 23 05 00	Common Works Results for HVAC
Section 23 07 00	HVAC Insulation
Section 23 09 00	Instrumentation and Control for HVAC
Section 23 23 00	Refrigerant Piping
Section 23 30 00	HVAC Air Distribution
Section 23 40 00	HVAC Cleaning Devices
Section 237000	Central HVAC Equipment
Section 23 80 00	Decentralized HVAC Equipment

1.3 Codes and Standards

1.3.1 Codes and standards applicable to this section shall be primarily British Standards and United States Codes, unless otherwise specified, the performance/manufacturing standards of items mentioned in this section shall confirm to the applicable portions of the latest editions of the following codes, standards and regulations.

Reference Code

Reference Code	Abbreviation	Applicable Standard	Title of Standard
American Society of Heating Refrigeration and Air Conditioning	ASHRAE	-	-
National Electrical Manufacturers Association	NEMA	-	-
National Electrical Code	NEC	Section 424	-
Air Moving and Conditioning Association	AMCA	-	-

National Fire Protection Association	NFPA	NFPA 90A	Standard for Air Conditioning and Ventilation Systems
ARI	ARI	-	American Refrigeration institute

1.4 Design Conditions

1.4.1 The air conditioning system is based on the following conditions

1.4.1.1 Outside summer conditions
97˚ F (36˚C) Dry Bulb
70˚F (21˚C) Wet Bulb
23˚F (13˚C) Daily range

1.4.1.2 Outside winter conditions
36˚F (2˚C) Dry Bulb

1.4.1.3 The inside summer conditions are indicated on the Drawings in the units capacity schedules.

PART 2 PRODUCTS

2.1 SPLIT SYSTEMS

2.1.1 Each split system shall consist of two major components, one condensing unit installed out door and one blower coil unit installed indoor. Both units are interconnected with copper pipes.

Each system shall be supplied complete with all necessary control wiring for its proper operation.

2.1.2 CONDENSING UNITS
2.1.2.1 General

2.1.2.1.1 Supply and install wherever shown on the Drawings condensing units of the direct expansion air-cooled type. Unit shall be factory-assembled into a compact, weather-proof cabinet with common base size. Each condensing unit shall be complete with casing, compressor, condenser, control panel, one main disconnect switch, vibration isolators and all electrical power and control wiring necessary for proper operation.

2.1.2.2 Casing

2.1.2.2.1 Casing shall be at least 18 gauge, zinc-coated steel, phosphatized and painted externally with epoxy resin primer and finished with an approved top coat Casing shall have a removable end panel, to allow for access to all components and connections, and die formed mounting rails integrated with unit base. Casing shall be provided with drainage holes in the base pan.

2.1.2.3 Compressor

2.1.2.3.1 Compressor shall be of the hermetic, reciprocating direct drive type with crank case heater, discharge line sound muffler and suction and discharge valves. Compressor shall have internal protection devices to provide protection for motor overload, locked rotor, and excessive winding temperatures.

2.1.2.4 Condenser Coil and Fans

2.1.2.4.1 Coil shall be of the seamless copper tubes with heavy aluminium fins mechanically bonded to the tubes, coil shall be factory pressure and leak tested at not less than 400 psig (2756 Kpa) air pressure. Condenser coil shall be protected by heavy-duty grille.

2.1.2.4.2 Condenser fans shall be statically and dynamically balanced of aerodynamic design, heavy duty motors. Each motor shall have built-in current and thermal overload protection and permanently lubricated ball bearings. Fan motor shall be provided with short circuit protective device(s).

2.1.2.4.3 Propeller Type Fans shall be of the direct drive type with fan motor support mounted to cabinet top. Fan shall have rugged steel guards for protection.

2.1.2.4.4 Centrifugal Type Fan: shall be of the double inlet forward- curved blades, belt driven with adjustable pulleys. Fan motor shall be capable to overcome specified static pressure.

2.1.2.5 Control panel

2.1.2.5.1 Condensing unit shall be equipped with a factory wired built-in control panel comprising: 24-volts control power transformer, magnetic contactors for compressor and condenser fan motors, high and low pressure cutouts, non-recycling pump down and reset relay, and all necessary timers, and control relays and protective devices.

2.1.3 BLOWER COIL UNITS

2.1.3.1 General

2.1.3.2.1 Supply, install, and connect (refrigerant piping, power and electrical wiring) wherever shown on the Drawings factory assembled blower coil units consisting of casing, direct expansion evaporator coil, fan, motor, insulated drain pan and throwaway filters. Each unit shall be supplied complete with expansion valve, drier, liquid sight glass, electrical wiring and vibration isolators.

2.1.3.2 Casings

2.1.3.2.2 Casing shall be not less than 20 gauge steel with baked on enamel finish, lined with not less than 13 mm thick, neoprene coated insulation. Casing shall be provided with removable access panel for full access to all components, and shall be provided with mounting holes for suspended mounting.

2.1.3.3 Coils

2.1.3.3.1 Cooling coils shall be seamless copper tubes with heavy aluminium fins mechanically bonded to the tubes. Coil shall be complete with male couplers, and operating charge of R-22 and shall be factory pressure and leak tested at not less than 200 psig (1380 Kpa).

2.1.3.4 Fan Motors

2.1.3.4.1 Fan shall be of the double inlet centrifugal type with forward-curved blades, belt driven, with an electric 3 speed motor having permanent split capacitor (for single phase motors only) and built-in thermal over load protection. Fan and motor bearings shall be of the permanently lubricated type.

2.1.3.5 Remote Control Station

2.1.3.5.1 Supply and install a remote control station wherever shown on Drawings complete with thermostats, on /off switches, controllers and all components indicated on the Drawings together with all the control wiring and its connections to the blower & condensing unit.

2.2 Mini-Split System

2.2.1 Mini split system shall cover a range up to three tons of refrigeration and shall consist of a condensing unit, an evaporator blower unit, and refrigerant piping network between the blower coil and the condensing unit, reverse cycle for heating and cooling.

2.2.2 Condensing Unit

2.2.2.1 Condensing unit shall be of the air cooled type completely assembled at the factory and shall consist of the following:

- Phosphatized zinc coated steel casing.
- Reverse Cycle for heating and cooling
- Hermetic Compressor.
- Air cooled condenser and condenser fan.
- All necessary controls and accessories for automatic and proper operation.

2.2.3 Evaporator Blower Unit

2.2.3.1 The evaporator blower unit shal.1be installed indoors and shall be of the type indicated on the Drawings ..

2.2.3.2 The unit shall be complete with:

- Evaporator cooling unit.
- Centrifugal 3-speed blower and blower motor.
- Cleanable filter.
- Remote thermostat, thermometer, speed selector switch and time control.
- Decorative cabinet if installed exposed.
- Electric heating element (if shown on Drawing).

2.3 Air Cooled VRF High Ambient System

2.3.1 Features

2.3.1.1 The system shall control flow of refrigerant through indoor units, by means of an electronic expansion valve fitted in each indoor unit.

2.3.1.2 The system shall be capable of cooling with external ambient temperatures from -5°C to +50°C.

2.3.1.3 The equipment manufacturer shall be responsible for the manufacture of the compressor, refrigerant oil and refrigerant used within the system to maintain integrity of design and optimize efficiency and reliability of equipment.

2.3.1.4 The system shall have the ability to sustain refrigerant piping lengths of up to 165m with a level difference up to 50m between fan coil units and condensing unit if the outdoor unit is located above the highest level indoor unit. An option shall be available to increase the level difference of the pipe work to 90m between fan coil units and condensing unit if the outdoor unit is located above the lowest level indoor unit.

2.3.1.5 Each independent system shall be capable of having up to 1DOOmof refrigerant pipe work installed. The system shall be capable of having up to 90m refrigerant pipe length from the first refnet joint to the furthest indoor unit, after incorporating relevant system design guidelines.

2.3.1.6 The system shall operate with Refrigerant that should provide maximum temperature glide of less than 0.17K to avoid fractionation problems and meet Estidama requirements; i.e. Ozone depiction potential (ODP) equal to zero. The unit shall be factory assembled and charged with ECO friendly refrigerant.

2.3.1.7 All equipment shall be run tested in accordance with the following procedures prior to leaving place of manufacture.

2.3.1.7.1 A choke test carried out on the refrigerant piping to detect obstacles

2.3.1.7.2 The pipework shall be tested to 38bar.

2.3.1.7.3 Electronic leak testing shall be carried out to ensure maximum system refrigerant containment.

2.3.1.7.4 System vacuum test to 2 Torr

2.3.1.7.5 Refrigerant test to within 0.3%

2.3.1.7.6 Electrical tests shall include flash testing at 1440V AC to ensure that current leaks above 5mA are detected, megger test at 500V DC to ensure resistance levels are above 10 mega Ohm and earth continuity tests.

2.3.2 Outdoor Units

2.3.2.1 The units shall be heat pump air-cooled type incorporating heat exchanger coils manufactured from copper tubes and aluminium fins, factory treated to reduce the effect of atmospheric corrosion.

2.3.2.2 The unit casing shall be manufactured from (701-1) polyester powder coated baked enamel finish sheet steel in order to have a high corrosion resistance and to protect against salt laden environment.

2.3.2.3 The outdoor units shall have inverter driven compressor (Variable Frequency Drive Compressors and capable of soft start compressor shall be electronically controlled and capable of changing speed linearly to follow the variation in cooling or heating requirements.

2.3.2.4 The compressor shall be scroll type with fixed and orbiting scrolls. The low pressure refrigerant shall be fed directly into the scroll and the discharge refrigerant shall cool the motor windings and place the compressor shell under discharge pressure..

2.3.2.5 The lubrication oil of the compressor shall be fed through the centre of the crankshaft and then across the complete area of the scrolls from the centre outwards to ensure the complete contact area is positively lubricated maximizing compressor efficiency and minimizing wear and tear.

2.3.2.6 The outdoor unit fan motor shall be inverter driven and shall operate electronical.ly by sensing operational temperatures, pressures and ambient temperature and monitoring the dictates of the indoor units.

2.3.2.7 The units shall be complete with;

- VFD compressor,
- electronic expansion valve(s),
- oil separator(s),
- suction accumulator,
- high pressure switches,

- inverter driven fan motors,
- safety thermostat,
- over current relay,
- inverter overload protection,
- fuses,
- necessary solenoid valves,
- liquid shutoff valves,
- gas line shut off valves,
- short re-cycling guard timer and all necessary sensors for optimized,
- safe and trouble free operation.

2.3.2.8 Outdoor unit access to the internal components for maintenance purposes shall be by removable panels.

2.3.2.9 The fan will be capable of overcoming a minimum of 80 Pascal of external static pressure..

2.3.2.10 The units shall be capable of being combined to provide multi systems using combinations of two or more outdoor units connected to give the capability of higher capacities.

2.3.2.11 The unit shall be capable of carrying out automatically the calculated required additional refrigerant charge necessary to operate the system within its optimum efficiency. This cycle shall be completely automatic and provide a warning to the service technician to indicate when charging has been completed or the charging cylinder is empty.

2.3.2.12 The refrigerant cycle shall not rely upon float valves, level switches or weighed input of the refrigerant.

2.3.2.13 The calculated refrigerant charge shall be retained within the memory of the outdoor PCB as a reference for a refrigerant containment check which can be carried out as required to verify the correct refrigerant charge remains within the system.

2.3.2.14 The automatic refrigerant charging and containment check facilities shall be capable of being used at any time during the life of the system for any alterations or service operations which may be required.

2.3.3 Indoor Units

2.3.3.1 **Ducted unit (Ceiling concealed type)**

2.3.3.1.1 The fan motor should be DC inverter motor. The unit static pressure should be automatically adjustable from the unit wired remote controller (service mode).

2.3.3.1.2 The fan external static pressure should be at least 150 Pa at highest speed. However, the unit static pressure can be adjusted in the range between 30 and 2.00 Pa (at various speeds) to match the static pressure of the duct connected to that unit.

2.3.3.1.3 Unit sound pressure level shall not exceed 45 dba at high fan speed measured 1.5 m distance from the unit.

2.3.3.1.4 A condensate lift pump shall be provided within the unit and shall be capable of discharging above the drain outlet.

2.3.3.1.5 The unit casing shall be manufactured from galvanized steel plate and shall be fully insulated. Facility shall be provided for duct connection for introduction of fresh air to the unit and branch ductwork from the unit. The return air to the unit shall be through the back of the unit as standard.

2.3.3.1.6 The heat exchanger coils shall be manufactured from copper tubes and aluminium fins.

2.3.3.1.7 The unit shall have electronic expansion valve to control refrigerant flow rate in response to the load variation in the conditioned space. The expansion valve shall be controlled by an integral computerized PIO control system to maintain correct room temperature.

2.3.3.1.8 Units sound level shall be low enough to meet the noise levels specified for the served OZ underneath areas in Section 23 0548.

2.3.3.2 Large ducted type

2.3.3.2.1 The unit casing shall be manufactured from galvanized steel plate and shall be fully insulated. Facility shall be provided for duct connection for introduction of fresh air to the unit and branch ductwork from the unit. The return air to the unit shall be through the back of the unit as standard.

2.3.3.2.2 The fan shall be of the dual suction multi blade type, statically and dynamically balanced to ensure low noise and vibration free operation.

2.3.3.2.3 The heat exchanger coils will be manufactured from copper tubes and aluminium fins.

2.3.3.2.4 The unit shall have electronic expansion valve to control refrigerant flow rate in response to the load variation in the conditioned space. The expansion valve shall be controlled by an integral computerized PID control system to maintain correct room temperature.

2.3.3.2.5 Units sound level shall be low enough to meet the noise levels specified for the served OZ underneath areas in Section 23 05 48.

2.3.3.3 Small Ducted type

2.3.3.3.1 The unit casing shall be manufactured from galvanized steel plate and shall be fully insulated. Facility shall be provided for duct connection for introduction of fresh air to the unit and branch ductwork from the unit. The return air to the unit shall be through the back of the unit as standard.

2.3.3.3.2 The fan shall be of the dual suction multi blade type, statically and dynamically balanced to ensure low noise and vibration free operation.

2.3.3.3.3 The heat exchanger coils will be manufactured from copper tubes and aluminium fins.

2.3.3.3.4 The units shall have electronic expansion valve to control refrigerant flow rate in response to the load variation in the conditioned space. The expansion valve shall be controlled by an integral computerized PID control system to maintain correct room temperature.

2.3.3.3.5 Units sound level shall be low enough to meet the noise levels specified for the served OZ underneath areas in Section 23 05 48.

2.3.4 Ancillary Items

2.3.4.1 Proprietary REFNET joints and headers shall be used throughout the installation to reduce imbalance in refrigerant flow between indoor units..Size to be suggested and approved by the VRF manufacturer.

PART 3 EXECUTION

3.1 Spare Parts

3.1.1 The Contractor shall provide as part of his contract a list of spare parts for all the equipment supplied sufficient for three years of operation all in accordance with the recommendations of the manufacturers of the equipment.

3.2 Special Tools

3.2.1 A complete set of special tools, oil and grease for all the plant and equipment supplied, adequate for 12 months operation shall be supplied by the Contractor at the completion date of the project.

3.3 Operation and Maintenance Manuals

3.3.1 The Contractor shall furnish and submit to the Engineer in triplicate bound, A4 size, Instruction Manuals containing the following material:-

3.3.1.1 Brief description of each system and its service and basic operation features.

3.3.1.2 Manufacturer's mechanical equipment parts list of all functional components of the systems listed on the Drawings, control diagrams and wiring diagrams of controllers. List shall give system No., unit no., Manufacturer's Model No., and Manufacture's Drawing no. Parts list shall include manufacturer's recommended spare parts for one year operation.

3.3.1.3 Maintenance instructions for each type of equipment.

3.3.1.4 Possible breakdowns and repairs for each type of equipment.

3.3.1.5 List of nearest local suppliers for all equipment.

3.3.1.6 Manufacturer's literature describing each piece of equipment control diagrams and wiring diagrams of controllers.

3.3.1.7 Complete, as installed, colour coded wiring diagrams of all electrical motor controller connections and interlock connections of other mechanical equipment.

3.3.1.8 The Contractor shall furnish all the foregoing to the Engineer for his review as to the fulfillment of the specified requirements.

3.3.1.9 All items shall be available at least four weeks prior to the substantial completion date.

3.4 Guarantee and Warranteed Period

3.4.1 All equipment and accessories supplied by the nominated Sub-Contractor under this contract shall be guaranteed for a minimum period of one year and five years for compressors from the date of final completion certificate.

3.4.2 All guarantee shall be unconditional. In the event of breakdown, the Contractor shall immediately provide and install a replacement unit of equal or superior performance until such time as the original unit is repaired. Failure by the Contractor to comply within 6 hours of notification, will entitle the Employer to purchase or hire a replacement and seek reimbursement from the Contractor for all related disbursements.

3.4.3 The Contractor shall guarantee every piece of equipment from any manufacturing or installation defects for a period of one year, starting from the date of issue of the substantial completion certificate.

3.5 Approved List of Manufacturers:

3.5.1 For accepted products, Manufacturers and suppliers, refer to Appendix A.

<u>End of Section 23 81 00.</u>

SECTION 24 60 00
MEDICAL GAS, VACUUM AND WAGD SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS: Drawings and general provisions of the Contract, including general and supplementary conditions and Division I specification section, apply to this section.

1.2 SUMMARY EXTENT OF WORK

A. This Section pertains to all labor, equipment and services necessary for and incidental to the installation of piped medical gas and vacuum systems (PMGVS) including oxygen, medical air, medical vacuum, waste anesthesia gas disposal (WAGD), nitrogen, instrument air, nitrous oxide, helium, carbon dioxide, argon, dental air, dental vacuum, laboratory air and mixed gas systems as shown on the drawings and/specified herein.

1. Oxygen systems shall be complete to the source valve, ready for connection to the bulk gas supply system.

2. Medical Vacuum, WAGD and Medical Air systems shall be complete, started, tested and ready for use.

3. Nitrous Oxide, Nitrogen, Carbon Dioxide, Helium, Argon and Mixed Gas Systems shall be complete, tested and ready for use.

B. Owner Furnished Materials for installation under this section

1. Supply of gases in cylinders or containers as appropriate for manifolds.

2. Initial supply of liquid (oxygen, nitrogen).

3. Bulk Cryogenic (Oxygen, Nitrogen) System. Coordinate all plumbing and alarm connections to the bulk gas source, source start up and system testing, providing owner with system ready for use.

1.3 DEFINITIONS AND REFERENCES:

All references refer to the most recent edition.

A. National Fire Protection Association (NFPA), NFPA 99 Health Care Facilities.

B. National Fire Protection Association (NFPA), NEC National Electrical Code.

C. American Society of Sanitary Engineers (ASSE) 6010 Professional Qualification Standards for Medical Gas System Installers.

D. American Society of Sanitary Engineers (ASSE) 6030 Professional Qualification Standards for Medical Gas System Verifiers.

1.4 PERFORMANCE REQUIREMENTS

A. All materials used shall be new and of the best grade and quality obtainable and workmanship shall be first class in every respect. Contractor shall be responsible for compliance with all Local, State or Federal code

B. Provide all elements and accessories required for complete systems per NFPA 99 most recent edition.

C. Contractor shall make all necessary connections to owner furnished equipment.

D. Install all piping as shown on Drawings, as described herein, using methods of fabrication, grading, testing, repairing, cleaning and other procedures as described.

E. Electrical power wiring for vacuum pump(s), medical air compressor(s), WAGD Producer(s), ceiling columns, alarms, and modular accessories associated with the system(s) shall be part of the electrical contract. Any equipment supplied by this contractor that requires additional electrical services shall be the responsibility of this contractor to supply these services.

F. Perform Installer pressure testing, cross connection testing and final testing per NFPA 99 most recent edition and using procedures as specified.

G. Retain a qualified third party verifier acceptable to the engineer and owner to Perform and attest to final verification of the systems. Make corrections as required, including additional testing if necessary to attain full and unqualified certification.

1.5 COORDINATION

A. Medical Gas Contractor shall coordinate with other trades to ensure timely installations and avoid conflicts and interference.

B. Work with metal stud partition installer and/or mason to ensure anchors, sleeves and similar items are provided in sufficient time to avoid delays; chases and openings are properly sized and prepared.

C. Coordinate with owner to ensure medical gas outlets, whether owner supplied or contractor supplied, in walls, ceiling and all equipment is provided by the same Medical Gas Equipment Manufacturer (MGEM) satisfactory to the owner.

D. Coordinate with bulk cryogenic gas supplier for installation, connection and verification of bulk gas supply systems.

E. Medical Gas Contractor shall supply and install the master alarm system, including the signal wiring.
The electrical contractor shall provide power wiring to each alarm panel. Medical Gas Contractor is responsible for proper termination, testing and marking of alarm panels. Termination shall be done by or under supervision of manufacturer of alarm panels.

F. Coordinate with Medical Gas Verifier to deliver a complete, tested medical gas installation ready for owner's use.

1.6 SUBMITTALS

A. Furnish the following as one package:

1. Medical Gas Equipment Manufacturer (MGEM) submittals including at least;

a. Complete specifications for the product intended to be installed, dimensional drawings, and wiring schematics where appropriate.

c. For other medical gas products include: (i)

Outlet keying system.

(ii) Alarms networking instructions.

d. Complete installation instructions for the use of the installer.

e. Statement of specific compliance with paragraphs of NFPA 99 most recent edition as relevant to the equipment and as listed in those sections.

f. Complete maintenance schedules.

g. Warranty statement which must encompass all system components. Warranties covering only specific components or containing exclusions are not acceptable.

h. Name and contact information for installation assistance, startup, warranty and service. i.

Description of available Preventative Maintenance programs for Owners review.

j. Information on training programs available to maintenance personnel for Owners review.

B. Medical Gas Verifier Submittals shall include:

1. Name, contact information, MGPHO Credential Number and reference list. The reference list is to include not fewer than three references on projects of similar size and complexity.

2. A notarized affidavit from the verifier stating that the verifier undertakes to verify this project and thus agrees to disqualify themselves from supplying any equipment which will be included in the scope of their verification. No verifier who supplies equipment shall be permitted to verify that equipment or the system in which it is installed.

3. Statement declaring that the MGEM has no fiduciary interest in the verifier and that the verifier is not an agent or representative of the MGEM.

4. Statement declaring that the installing contractor has no fiduciary interest in the verifier and that the verifier has no fiduciary interest in the contractor.

C. Pre-approval;

1. Written pre-approval is required for equipment not exactly matching specifications. Submit the information required under Submittals above, attaching a cover letter stating the exact areas of deviation.

2. A Request for pre-approval of equipment must be received by the Engineer not less than three days (72 hours) prior to bid.

1.7 QUALITY ASSURANCE

A. Regulatory Requirements

1. Electrical Control systems and Medical Gas Alarms are to be UL listed as assemblies with label affixed.

2. Medical air, instrument air, medical vacuum and WAGD controls are to be wired in accordance with NEC.

3. MGEM will include with submittals an affidavit attesting to compliance with all relevant paragraphs of NFPA 99 most recent edition.

5. The Contractor shall furnish documentation attesting that all installed piping materials were purchased cleaned and complied with the requirements of NFPA 99 5.1.10.1 and 5.1.10.2.

6. The Contractor shall furnish copies of ASSE 6010 qualifications for all workers installing medical gas piping.

B. Installation and Start-up: The MGEM will provide factory authorized representatives to review installation and perform initial start up of system.

C. Warranty

1. Warranty will be expressly complete, include all components of the system and be the responsibility of the MGEM of record only. Warranties limiting the responsibility of the MGEM for any system component or which pass through the MGEM to another manufacturer are not acceptable.

2. Warranties shall include on site repairs including travel, labor and parts. Warranties requiring return of equipment for adjustment are not acceptable.

3. All medical gas pipeline components shall be warranted by the MGEM of record for a minimum of twelve months from start-up.

D. Maintenance

1. MGEM shall demonstrate a national factory direct service capability able to perform major overhauls.

2. MGEM shall offer factory direct preventative maintenance contract for the owner’s consideration.

3. MGEM shall offer formal maintenance training courses for owners review.

E. Verification: Medical Gas Contractor shall deliver to the owner a complete system certification without qualifications.

PART 2 - PRODUCTS

2.1 QUALIFICATION OF MANUFACTURER(S)

A. One Medical Gas Equipment Manufacturer (MGEM) shall supply the medical-gas system(s) and equipment to include outlets, valves and gauges, valve boxes, alarm panels, manifolds, medical air, instrument air, vacuum and WAGD sources.

B. The MGEM shall have a product specialist available to periodically check with the Contractor during installation of the pipeline systems equipment. MGEM shall provide service support to the hospital after turnover. Demonstrate factory trained service technician is available within 200 miles of facility.

D. Written Pre-approval is required for all equipment from other manufacturers.

2.2 MATERIALS

A. All pressurized medical gas piping shall be;

1. Seamless ASTM B-819, type K or L hard drawn seamless medical gas copper tubing, identified by the markings “OXY” “MED” “OXY/MED” “OXY/ACR” , or “ACR/MED” in green (Type K) or blue (Type L).

2. Fittings shall be wrought copper, brass or bronze designed expressly for brazed connection, compliant with ANSI B16.22.

3. Pipe (Tube), fittings, valves, and other components shall be specially cleaned for oxygen service in a facility equipped to clean, rinse, and purge the material in accordance with the requirements of NFPA 5.1.10.1.1 and received on job site cleaned and capped. On site cleaning of the interior surfaces of tubes, valves, fittings, and other components is not allowed.

4. Brazing alloy shall be BCuP-5 Brazing alloy or equivalent alloy with at least 1000 degree F melting point.

B. All vacuum tubing shall be:

1. Type ‘L’, ‘M’, or ASTM B-280 ACR copper.

2. Brazed with BCuP-5 Brazing alloy or equivalent alloy with at least 1000 degree F melting point.

C. All WAGD piping shall be:

1. Type ‘L’, ‘M’, or ASTM B-280 ACR copper, Schedule 5 galvanized steel, or equivalent sized ductwork.

2. If copper, brazed with BCuP-5 Brazing alloy or equivalent alloy with at least 1000 degree F melting point.

D. Isolation of copper tubing from dissimilar metal shall be accomplished either through use of copper or copper plated hangers or hangers with plastic isolators.

2.3 SUBSYSTEMS

A. MEDICAL GAS WALL OUTLET STATIONS:

2. Medical gas wall outlet stations shall be modular, quick-disconnect recessed type, or DISS screw thread recessed type. Threaded DISS connector shall be per CGA standards.

Provide keying systems compatible with existing keying system.

4. Outlets shall be field assembled with sequences and services indicated. Centerline spacing of multiple outlets shall be 5 inches minimum.

6. Outlet stations shall have a light gray coated Cycoloy® non-metallic trim plate. Furnish indexed rough in and gas specific latch valve with non-interchangeable safety keying and with color coded gas service identification. The safety keying index pins shall be permanently captured in the latch assembly and non-removable without destroying the outlet. Designs with index pins molded in plastic are not acceptable.

7. The latch mechanisms shall be designed for one handed, single thrust mounting and one handed fingertip release of secondary equipment.

8. The complete outlet shall be made, cleaned and packaged to NFPA 99 Standards, UL Listed and CSA certified. Medical gas outlets shall be cleaned for oxygen service in accordance with CGA Pamphlet G-4.1. The rough in and latch assembly shall be poly bagged for shipment.

9. The rough in assembly shall be of modular design and include a gas specific 16 gauge steel mounting plate designed to permit on-site ganging of multiple outlets, on 5 inch center line spacing. A machined brass outlet block shall be permanently attached to the mounting bracket to permit the 1/2” OD, type-K

copper inlet to swivel 360 degrees for attachment to the piping system. The rough in assembly shall contain a double seal to prevent gas leakage between the rough in and latch-valve assemblies after the wall is finished. The rough in shall have two features to prevent debris from entering outlet, one shall be the dust cover and the other will be a cap over the inter seal.

10. The latch-valve assembly shall telescope up to 3/4" to allow for variation in finished wall thickness from 1/2" to 3/4".

11. All vacuum outlets shall have a pressure plug for testing purposes.

B. MEDICAL GAS CEILING OUTLETS:

1. DISS Outlets shall be used for all ceiling mount applications.

3. Inlet pipe shall come straight out the outlet body (not 90 degree) for easier installation.

4. Furnish hose assemblies for all ceiling outlets for the finished ceiling height as indicated on drawings. Provide each hose with a heavy-duty dual retractor for pressure gases and dual for vacuum. The hose retractor wire is manufactured out of 48" stainless steel heavy duty cable. Allow an extra 18" of hose length for retractors.

C. GAS (NIT, CO2, INA) CONTROL PANELS:

1. Gas control panels shall be designed to deliver variable pressures to power pneumatic surgical tools.

2. The control panel shall be provided with a 0-300 psig pressure gauge, shutoff valve, pressure regulator, delivery pressure gauge and outlet. A quarter turn of the valve handle shall be required to obtain a fully "open" or "closed" position.

3. An adjustable self relieving type pressure regulator, with a operating range of 10 to 250 psi.

4. Control panels shall be pre-piped internally requiring only external supply line connections. Additional outlets in the same room may be connected to the remote outlet pigtail furnished in the control panel. Remote outlets shall be regulated by the adjustable pressure regulator within the panel and shall match the nitrogen control panel outlet.

5. Control panels shall be available in horizontal or vertical orientation.

D. MEDICAL GAS VALVES

1. All Medical Gas Valves shall be specially prepared for oxygen service and shall conform to NFPA 99. Valves shall be ball-type, with Teflon seats and adjusting stem packing gland with Teflon stem seal.

2. Ball valves shall be rated 600 WOG, actuate from full "ON" to full "OFF" by 90 degree turn of vinyl gripped valve handle.

3. Furnish and install only valves with factory installed type K copper tubing extensions.

4. Valves not in valve boxes shall be provided with locking handles. (locks to be provided by contractor to owner).

5. Ball valves shall have dual ports.

6. All valves shall be cleaned for oxygen, capped and sealed in a polyethylene bag for shipping and storage.

E. ZONE VALVE BOXES

1. Valve boxes shall be constructed of 18 gauge steel with white enamel finish. The valve box shall have a pull out, opaque door with pull ring and clear gauge window. The removable window cannot be replaced when any valve is closed. The frame assembly shall be capable of adjusting for variances in wall thickness up to 1-3/16". The window shall conceal piping and mounting screws. Window shall be labeled "Caution - Medical Gas Shut - Off Valves - Close Only in Emergency." Provide clear viewing space in the window to display the gas service, the pressure gauges and the label for areas controlled by the valve.

2. Provide color coded self-adhesive gas labels for compliance with NFPA 99 labeling requirements.
Apply labels to each valve in the assembly for gas service identification according to manufactures recommendations.

3. Valve box shall house one to six valves.

4. Zone valves shall include a 1 1/2 inch pressure gauge reading 0 to 100 psig for oxygen, air, nitrous oxide; 0 to 300 psig for nitrogen; and 0 to 30 HG for vacuum and WAGD. The gauge port shall be equipped with removable plug for pressure testing before final assembly of gauge.

5. All zone valve boxes assemblies shall read pressure downstream and vacuum upstream of the valve per NFPA 99. Valves shall be piped left to right with right being on patient side.

6. All main line, riser, service, and futures valves as scheduled on the drawings shall include plugged
1/8 nptf ports on inlet and outlet.

F. ZONE VALVE BOX WITH SENSOR FOR REMOTE ALARM

1. Valve boxes shall be constructed of 18 gauge steel with white enamel finish. The valve box shall have a pull out, opaque door with pull ring and clear gauge window. The removable window cannot be replaced when any valve is closed. The frame assembly shall be capable of adjusting for variances in wall thickness up to 1-3/16". The window shall conceal piping and mounting screws. Window shall be labeled "Caution - Medical Gas Shut - Off

Valves - Close Only in Emergency.” Provide clear viewing space in the window to display the gas service, the pressure gauges and the label for areas controlled by the valve.

2. Provide color coded self-adhesive gas labels for compliance with NFPA 99 labeling requirements. Apply labels to each valve in the assembly for gas service identification according to manufactures recommendations.

3. Valve box shall house one to six valves.

4. Zone valves shall include a 1 1/2 inch pressure gauge reading 0 to 100 psig for oxygen, air, nitrous oxide; 0 to 300 psig for nitrogen; and 0 to 30 HG for vacuum and WAGD. The gauge port shall be equipped with removable plug for pressure testing before final assembly of gauge.

5. All zone valve boxes assemblies shall read pressure downstream and vacuum upstream of the valve per NFPA 99. Valves shall be piped left to right with right being on patient side.

6. Each valve shall have a gas specific DISS demand check valve for installation of a DISS gas specific sensor. Low voltage wiring to remote alarm by this contractor

7. Area alarm will not require sensors.

G. COMBINATION ZONE VALVE/AREA ALARM

1. Valve boxes shall be constructed of 18 gauge steel with white enamel finish. The valve box shall have a pull out, opaque door with pull ring and clear gauge window. The removable window cannot be replaced when any valve is closed. The frame assembly shall be capable of adjusting for variances in wall thickness up to 1-3/16”. The window shall conceal piping and mounting screws. Window shall be labeled “Caution - Medical Gas Shut - Off Valves - Close Only in Emergency.” Provide clear viewing space in the window to display the gas service, the pressure gauges and the label for areas controlled by the valve.

2. Provide color coded self-adhesive gas labels for compliance with NFPA 99 labeling requirements.
Apply labels to each valve in the assembly for gas service identification according to manufactures recommendations.

3. Valve box shall house one to six valves.

4. Zone valves shall include a 1 1/2 inch pressure gauge reading 0 to 100 psig for oxygen, air, nitrous oxide; 0 to 300 psig for nitrogen; and 0 to 30 HG for vacuum and WAGD. The gauge port shall be equipped with removable plug for pressure testing before final assembly of gauge.

5. All zone valve boxes assemblies shall read pressure downstream and vacuum upstream of the valve per NFPA 99. Valves shall be piped left to right with right being on patient side.

6. Each valve shall have a gas specific sensor installed with DISS nut & nipple.

7. The area alarm shall be part of the valve box. No remote alarm shall be required.

H. MEDICAL GAS ALARM SYSTEMS

1. General Requirements

a. All Medical Gas Alarm panels shall be UL listed as an assembly and shall include factory wiring, transformers, and circuitry requiring only 115 or 230 volt primary power.

b. Alarm panels shall meet the FCC Part 15, Subpart B and ICES-003 to reduce possibility of magnetic radiation interference with other equipment.

c. The alarm shall arrive on the job site pre-configured as shown on the drawings and schedules or shall be configured by MGEM personnel at no additional charge.

d. Alarm shall supervise its wiring to sensors and switches, indicating at the relevant panel(s) if any wire is cut, disconnected or open.

e. Each signal will include an indicator light to signify the condition monitored. Activation of any switch will light its LED or LCD “Tag Name” and actuate the audio alarm.

f. Each panel shall include a power on indicator and test function for testing all modules electrically.

g. Alarms shall include features permitting field adjustment of alarm volume and display intensity.

h. Termination of alarm wiring to be done by or under supervision of manufacturer of alarm.

3. Area Alarms

a. Each area alarm shall include a rough in including power supply, a sensor for each specific gas, and one digital display for each specific gas.

b. The power supply shall be of the universal switching type (100-250VAC, 50/60/440Hz, 120-300VDC). Power supply shall be fused to protect the system from voltage and amperage surges. Alarm shall clearly indicate when power is on.

c. The area alarm shall provide an audible and visual signal when an advisory or a fault signal is received. Signal limits shall be factory set, with the ability to be field adjusted without the use of tools.

d. Each panel shall provide continuous digital display of the vacuum or pressure, high pressure LED indicator, low pressure (or vacuum) LED indicator and a Normal LED indicator.

e. The Sensor shall contain a transducer to drive the Digital Module. Sensors shall be gas specific, provided with integral demand checks and capable of mounting directly in the gas pipeline system above the ceiling. Connectors shall be provided for attaching field wiring.

f. Furnish and install the alarm. Coordinate the power wiring with Division 16. Low voltage shielded signal wiring will be provided and installed by this contractor.

g. Termination of signal wiring at alarm location will be done by or under supervision of manufacturer of alarm.

PART 3 - EXECUTION

3.1 INSTALLATION

Pipe work

1. All installation shall be performed in strict accordance with NFPA 99 5.1.10. Brazing procedures shall be as detailed in NFPA 99 5.1.10.5. Brazing shall be performed only by braziers qualified under NFPA 99 5.1.10.10.11.

2. Where piping runs underground, install in accordance with NFPA 99 5.1.10.10.5.

3. Copper, tubing, valves and fittings shall be pre cleaned and prepared for oxygen service by the manufacturer and received sealed on the job. Certificates of origin and of proper preparation shall be maintained on the job site attesting the above.

4. The use of flux is prohibited when making of joints between copper to copper pipes and fittings.

5. During any brazing operation, the interior of the pipe shall be purged continuously with oil free, dry nitrogen NF, following the procedure in NFPA 99 5.1.10.5.5. At the completion of any section, all open pipe ends shall be capped using an EXTERNAL cap.

6. Threaded joints in piping systems shall be avoided whenever possible. Where unavoidable, make up the male threads with polytetrafluorofethylene (such as Teflon) tape or other thread sealant recommended for oxygen service, with the sealant applied to the male threads only.

7. Piping shall be supported with pipe trays or hangers at intervals as shown on the drawings or as defined in NFPA 99 Table 5.1.10.10.4.5. Piping shall not be supported by other piping. Isolation of copper piping from dissimilar metals shall be of a firm, positive nature. Duct tape is not acceptable as an isolation material.

8. After installation of the piping, but before installation of the outlet valves, blow lines clear using nitrogen NF.

9. Piping exposed to physical damage shall be protected.

10. Label piping with name of gas service, identification color and direction of flow. Where

non-standard pressures are piped, label for pressure. Labels shall be placed at least once every 20 feet of linear run or once in each story (whichever is more frequent). A label shall additionally be placed immediately on each side of each wall or floor penetration. Pipe labels shall be self adhesive vinyl or other water resistant material with permanent adhesive colored in accordance with NFPA 99 Table 5.1.11 and shall be visible on all sides of the pipe. Pipe labels shall be BeaconMedæs Series 6-435.

11. Alarms and valves shall be labeled for gas service and areas monitored or controlled. Coordinate with owner for final room or area designations. Label valves with name and identification color of the gas and direction of flow.

12. Piping penetrating an electromagnetic shield shall have an isolation device on each side of shield.

Labeling

1. Label the medical gas pipelines per NFPA 99 5.1.11 and as follows:

a. Label each master alarm signal for function after ring out.

b. Label each zone valve and area alarm for the area of control or surveillance after test.

2. Labels shall be permanent and of a type approved by the owner.

3.2 INSTALLER TESTING

A. Prior to declaring the lines ready for final verification, the installing contractor shall follow strictly the procedures for verification as described in NFPA 99 5.1.12.2 and attest in writing over the notarized signature of an officer of the installing company the following;

1. That all brazing was conducted by brazers qualified to ASSE 6010 and holding current medical gas endorsements.

2. That all brazing was conducted with nitrogen purging. (Procedure per NFPA 99 5.1.10.5.5).

3. That the lines have been blown clear of any construction debris using oil free dry nitrogen or air are clean and ready for use. (Procedure per NFPA 99 5.1.12.2.2).

4. That the assembled piping, prior to the installation of any devices, maintained a test pressure 1 1/2 times the standard pressures listed in NFPA 99 Table 5.1.11 without leaks. (Procedure per NFPA 99 5.1.12.2.3).

5. That after installation of all devices, the pipeline was proven leak free for 24 hours at a pressure 20% above the standard pressures listed in NFPA 99 Table 5.1.11. (Procedure per NFPA 99 5.1.12.2.2.6)

6. That the systems have been checked for cross connections and none were found. (Procedure per NFPA 99 5.1.12.2.4)

7. That the manufacturer has started up all medical air compressors, medical vacuum pumps WAGD producers, liquid oxygen system(s) and manifolds, and that they are in operating order.

B. Provide four originals of the affidavit, distributed; (1) to the engineer, (1) to the owners representative, (1) to the general contractor and (1) to the verifier.

3.3 VERIFIER TESTING

A. Prior to handing over the systems to the owner, contractor shall retain a Verifier acceptable to the engineer and owner who shall follow strictly the procedures for verification as described in NFPA 99
5.1.12.3 and provide a written report and certificate bearing the notarized signature of an officer of the verification company which contains at least the following:

2. An affidavit bearing the notarized signature of an officer of the verification company stating that the verification company is not the supplier of any equipment used on this project or tested in this report and that the verification contractor has no relationship to, or pecuniary interest in, the manufacturer, seller, or installer of any equipment used on this project or tested in this report

3. A listing of all tests performed, listing each source, outlet, valve and alarm included in the testing.

4. An assertion that all tests were performed by a MGPHO Certified Medical Gas Verifier (CMGV) or by individuals qualified to perform the work and holding valid qualifications to ASSE 6030 and under the immediate supervision a CMGV Verifier. Include the names, credential numbers and expiration dates for all individuals working on the project.

5. A statement that equipment used was calibrated at least within the last six months by a method traceable to a National Bureau of Standard Reference and enclosing certificates or other evidence of such calibration(s). Where outside laboratories are used in lieu of on site equipment, those laboratories shall be named and their original reports enclosed.

6. A statement that where and when needed, equipment was re-calibrated during the verification process and describing the method(s) used.

7. A statement that the systems were tested and found to be free of debris to a procedure per NFPA 99 5.1.12.3.7.

8. The flow from each outlet when tested to a procedure per NFPA 99-5.1.12.3.10.

9. A statement that the systems were tested and found to have no cross-connections to a procedure per NFPA 99 5.1.12.3.3.

10. A statement that the systems were tested and found to be free of contaminants to a procedure per NFPA 99 5.1.12.3.8 except that the purity standard shall be 2 ppm difference for halogenated hydrocarbons and 1 ppm total hydrocarbons (as methane).

11. A statement that all local signals function as required under NFPA 99 5.1.3.4.7 and as per the relevant NFPA 99 sections relating to the sources.

12. A listing of local alarms, their function and activation per NFPA 99 5.1.12.3.14.

13. A listing of master alarms, their function and activation, including pressures for high and low alarms per NFPA 99 5.1.12.3.5.2.

14. A listing of area alarms, their function and activation pressures per NFPA 99 5.1.12.3.5.3.

15. A statement that the sources include all alarms required by NFPA 99 Table A.5.1.9.5.

16. The concentration of each component of NFPA 99 Table 5.1.12.3.12 in the medical air after 24 hours of operation of the medical air source.

17. The concentration of each gas at each outlet as specified in NFPA 99 5.1.12.3.11.

18. A statement that all valves and alarms are accurately labeled as to zone of control.

B. Provide four originals of this affidavit, and report, distributed; (1) to the engineer, (1) to the owner's representative, (1) to the general contractor and (1) to the installing contractor.

END OF SECTION

SPECIAL CONDITIONS

Augusta Victoria Hospital Renovation and Rehabilitation
Mount of Olives, Jerusalem.

SPECIAL CONDITIONS OF CONTRACT

- By the completion of works, and prior to the final payment request, the contractor shall provide the Hospital administration the following:
  - Certificate of pass for the Electrical works, in compliance with the Israeli Standards Institute (makhon hatkanim), and Hospital works regulations.
  - Certificate of pass for the Safety, security and fire fighting works, in compliance with the Israeli Standards Institute (makhon hatkanim), and Hospital works regulations.
  - Certificate of pass for the Mechanical works, in compliance with the Israeli Standards Institute (makhon hatkanim), and Hospital works regulations.
  - As built drawings for the Architectural, Civil, Mechanical, Electrical works, and any other works done by the contractor.
  - Manuals, warranties & guarantees, and maintenance schedule for all supplied appliances, machinery and others.

- Time schedule and traffic path of supplied and disposed materials, shall be submitted for approval by Augusta Victoria Hospital administration and Design & supervision Team

- Time schedule of working hours to be submitted for approval by Augusta Victoria Hospital administration and Design & supervision Team

- Only legal Workers who are authorized to work in Jerusalem are allowed to Work in Augusta Victoria Hospital

- Workers are not allowed to be in any other departments and/ or hospital facilities, not related to this contract works, prior to an official approvals.

- Hospital Policies are to be followed and are not limited to the smoking policy.

Safety measurements as required by Augusta Victoria Hospital

1. The contractor should supply and install gypsum walls, as per the attached drawing, close all openings and make sure the work location is isolated completely from other hospital sections, by means of sticky mat on the floorings, in order to keep it clean.
2. The gypsum walls include gypsum doors 120cm width, with locks.
3. The contractor and his workers and the sub-contractors, are not allowed to use the main hospital doors.
4. Entrance and exit of goods, work appliances, and contracting team, is achieved only through the hospital windows on the north elevation, and only after coordinating with the hospital security team.
5. Submit safety plan, prepared by a safety specialist, and get approvals from the concerned departments, before the construction.
6. The necessity of the use of dust hoods in the site, and not to cut stone or tiles in there.
7. The contractor is take into consideration all required safety measurements according to local and hospital rules. The hospital will have periodic visits, and it has the right to suspend the contractor's work if he does not follow these rules.
8. The contractor should commit not to disrupt any of the hospital's services, such as electricity, medical gases, water, elevator, firefighting system, heating system, and drainage system.
9. Supply the site with caution signs, such as construction area, keep out, danger, no smoking, etc.…
10. The site is to be supplied by a number of fire fighters, which are to be equally distributed throughout the site.
11. The contractor is to present the firefighting approval on all drawings before construction.
12. The contractor is to provide the hospital with names of all working teams. The hospital will prepare name tags to be put during construction.
13. The contractor is to detach fire alarm system for the construction site from other hospital parts, to avoid false fire alarms.
14. The contractor and the hospital's administration and safety team are to agree on a way to dismantle waste from the site, with minimum damage and maximum safety considerations.

15. Close the trash location where the waste is to be collected.
16. Train all members of construction team on fire and safety measurements in case of emergencies.

******* END OF SECTION *******