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Electrical Book Of Specifications



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Electrical Works Technical Specifications

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Division 16

ELECTRICAL WORKS

Preambles

Preambles:

1. General:

- 1.1 Each section referred to in the bills of quantities shall be read in conjunction with the respective section and with all other sections of specifications.
- 1.2 The bills of quantities, specifications, schedules of equipment, drawings and all other contract documents are complementary to each other.
- 1.3 It is highly advisable that the contractor read the preamble prior to quoting his prices.
- 1.4 It should be understood that the unit rates of the bill of quantities items cover all needed materials , workmanship, equipment, accessories ... etc. needed to complete the work, regardless to whether they are stipulated in the items' description or not.
- 1.5 It is the responsibility of the contractor to check the locations and quantities of the materials and equipments which should be executed in accordance with the contract drawings.
- 1.6 The unit rate of the materials and equipment - supplied by the contractor -should be as specified under each item concerned in the B.O.Q.
- 1.7 Manufacturers of equipment, materials and other accessories - supplied by the contractor - should be as specified in the list of approved manufacturers or equivalent.
- 1.8 Equivalent items should be equal in quality, standards, application and price.
- 1.9 Owner reserves the right to increase or decrease the quantity of works specified in the Bill of Quantities, regardless of the percentage of change in quantities, without any change in unit price or other terms.

2. Rates:

The unit rate of each item mentioned in the B.O.Q. shall include the following:

- 2.1 Provide 3 sets of each of workshop drawings, calculation sheets and as built drawings.
- 2.2 Provide samples of high quality and standard, and manuals for electrical materials and equipment for all systems, according to specifications and drawings, all for engineer's study and approval.

- 2.3 Provide 3 sets of operation, maintenance manuals and training.
- 2.4 Provide spare parts and components for ideal running of all services and equipment.
- 2.5 Off – loading, handling and storing for electrical materials and equipment.
- 2.6 Labor, materials, tools, instruments, electric power and fuel required for installation, insulation, cleaning, testing, adjusting, operation, and whatever required for commissioning.
- 2.7 Replacement of any damaged or disinfected electrical material or equipment.
- 2.8 Cleaning and proper protection for all equipment plants and electrical installations.
- 2.9 Electrical and control connections for the electrical equipment where required.
- 2.10 Electrical works including all required materials, accessories, labor, all as required according to drawings, specifications and bill of quantities.
- 2.11 Cutting, and pinning including all making good
- 2.12 Forming, or cutting haies, chases, channels etc. in reinforced concrete structure, block works or existing walls.
- 2.13 Plugging and screwing.
- 2.14 Testing electrical installations as specified including providing and personal necessary for testing, providing written certificates for testing results.
- 2.15 Preparation of all electrical works.
- 2.16 Removing all unneeded electrical installations (if any) and keeping in good condition in coordination with the engineer.
- 2.17 All outlets, switches, cables, wires should be labeled (numbers & tags).
- 2.18 All conduits used should be fire retardant and color coded.

End of Preambles

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. RELATED WORKS SPECIFIED ELSEWHERE

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. Authorities and Regulations**

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

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

1.04 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 were 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 be 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. **Shop Drawings**
 1. Prepare and submit for approval, before commencing any portion of the Contract work, complete shop drawings, which shall show:
 - Exact routes of cables and ducts including sizes and details of installation.
 - Cable trays and ladders giving routes, sizes and details of supports and hangers.
 - Exact runs of conduits and trunking including sizes, draw boxes and junction boxes and the number and sizes of wires in each run.
 - Switch boards and distribution boards and control panels including location, layout, dimensions, fixing details, cabling and final connection arrangement.
 - Proposed supports and hangers for cable trays, trunking, conduits, cables, 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 recommended 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 though such quality may not be stated specifically in the specifications. All materials and products shall be new and manufactured by well known firms and shall be sound and uniform in quality, size, shape, color and texture and shall be free from cracks, 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 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 manufacturer's 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 ampacities. 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 inrush 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 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 be adopted as hanger rods for cable trays, trunkings, ladders etc.

PART 3 - EXECUTION

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 BARRIERS)

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 authorities as similarly applicable to cable trays and Trunking.

1.03 RELATED WORKS SPECIFIED ELSEWHERE

- A. Section 16200 Cables & Wires
- B. 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:**
 - 1. Name of the manufacturer.
 - 2. Country of origin.
 - 3. Name and address of agents stating whether any manufacturing or fabrication is carried out locally.
 - 4. Method of obtaining spare parts for maintenance and list of spare parts sufficient for a 2 years period.
 - 5. Technical performance of the equipment selected.
 - 6. Dimensional details needed for installation and maintenance.
 - 7. Delivery time from the date of orders.
 - 8. Copies of test reports or certificates.
 - 9. 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 °C, and shall not slump up to a temperature of 149 °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 mm² 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)

IEC 439 (Part 1-4)

Low Voltage Switchgear & Control Gear

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 sleeveings 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 $I_{cs}=I_{cu}=I_{cw}$ 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 electrodynamic 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 $10^6 \text{ A}^2\text{s}$ for ratings up to 250A and $5 \times 10^6 \text{ A}^2\text{s}$ 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 under voltage 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 earth faults 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 as 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 be 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 CONTACTORS

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, contactors 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 $\pm 15\%$ at 50Hz
Output	415V AC $\pm 2\%$ 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 2.5mm² 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 manufacture 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. Data 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.
 - Fixture (Recessed type)
 - i. For the lighting fixture (recessed in F.C) the contractor shall obtain from the 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%:

<u>Location/Function</u>	<u>Min. Service Illuminance (LUX)</u>
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 contained, 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°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°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°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 luminaires 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 resistivity 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 16670
LIGHTNING PROTECTION

PART 1 GENERAL

1.01 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 all sections of this Division particularly 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.

1.02 SCOPE OF WORK

- A. This section includes for the complete supply and installation of the lightning protection system specified hereinafter and as detailed on the drawings.
 - 1. The system shall consist of metallic air terminals as shown on the drawings. The down conductors shall drop to the base of the Radome support structure. The structure and all metal objects in the Radome to be bonded to the down conductor, with removable link provided.
 - 2. At the base of the Radome additional air-terminals shall be installed and connected to the down conductors, as shown on the drawings.
 - 3. The down conductors shall continue to drop as shown on the drawings. Additional air terminals shall be installed at roof level and connected to the down conductor network installed around the roof.
 - 4. All curtain wall mullions shall be bonded together at roof level and joined to the copper air terminals by means of bimetallic connectors.

1.03 QUALITY ASSURANCE

- A. Lightning Protection system work shall be performed by one firm specializing in the installation of such systems.

1.04 SUBMITTALS

- A. Reference Applicable Divisions - Submittals.
- B. Reference Applicable Divisions - shop Drawings, Product Data and Samples
- C. Provide a shop drawings riser diagram of the lightning protection system detailing dimensions of all material and equipment.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Air terminals: PVC insulated copper tape not less than 25mm x 3mm and upright copper rods (finials)
- B. Down Conductors: Copper tape not less than 25mm x 3mm PVC sheathed, colour as specified by the Architect./50 mm² CU insulated cable
- C. Fastening and attachment straps, brass.
- D. Test Clamps: Brass and/or gun metal of solid manufacture to accept copper down conductors separated from copper earth electrode conductors.
- E. Electrodes: solid copper rods, extendable type 1.5 metres long x 19mm diameter, phosphor bronze coupling screw, hardened steel tip, hardened steel driving cap.
- F. Flexible Ground Connections: Single core stranded copper conductors PVC sheathed colour green, and yellow, size as indicated.
- G. Test Pit: Concrete test pit with removable cover for periodic testing of earth electrodes.
- H. Connector pit, concrete pit precast with removable granite paver as cover. Provide lamacoid labial inside pits.
- I. Aluminum conductor, may be tape or single flexible cable, to suit mullion detail.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install lightning protection as indicated in accordance with the local codes and BS 6651 :1992.
- B. the down conductor shall be clamped to the Radome support structure and taken to the roof level. All metal materials in the Radome shall be bonded to the down conductor, through removable links.
- C. At the base of the Radome on the concrete structure of the building install additional air terminals as detailed. Down conductors shall be installed and taken to the roof level to be continued down.
- D. where an air termination is installed on the roof, support the tape on raised pads to allow the run of rain water. Weld air termination systems to down conductors.
- E. install air terminals and tape on the parapet walls of the roof structure. Connect all tapes and install down conductors as detailed.
- F. Bond air terminations on roof to steel reinforcement bars by means of bimetallic connectors as shown on drawings.
- G. Down conductors shall terminate at ground level in test pits below pavement.
- H. Install down conductors vertically with fixing clips every 2 meters and terminate at grade level in test clamp.
- I. Install the earth electrodes 4 metres into the ground plus additional sections to obtain the correct readings at each electrode less than 10 Ohms.
- J. Connect and bond all equipment mounted on roof in addition to any metallic installations to the air termination network.
- K. Bond curtain wall vertical mullion sections together by means of an Aluminium connector at a maximum of 10m mullion to mullion horizontal distance. Connect to the nearest lightning pit at grade by means of a bimetallic connector and copper tape.
- L. Test system in accordance with section 16030.

*** 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 alphanumeric 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 conforming 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 sectorized 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.

PART 2 PRODUCT

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	Color	Conductor	Insulation
Material		Diameter (mm)	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 (°C) –20 to +60

Installation (°C) 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 (Ω/km)
 Resistance unbalanced, max (%)2
 Optical braid overage (%)41
 Transfer impedance, IEC 96-1
 1 MHz (Ω/m) 5
 10 MHz (Ω/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.

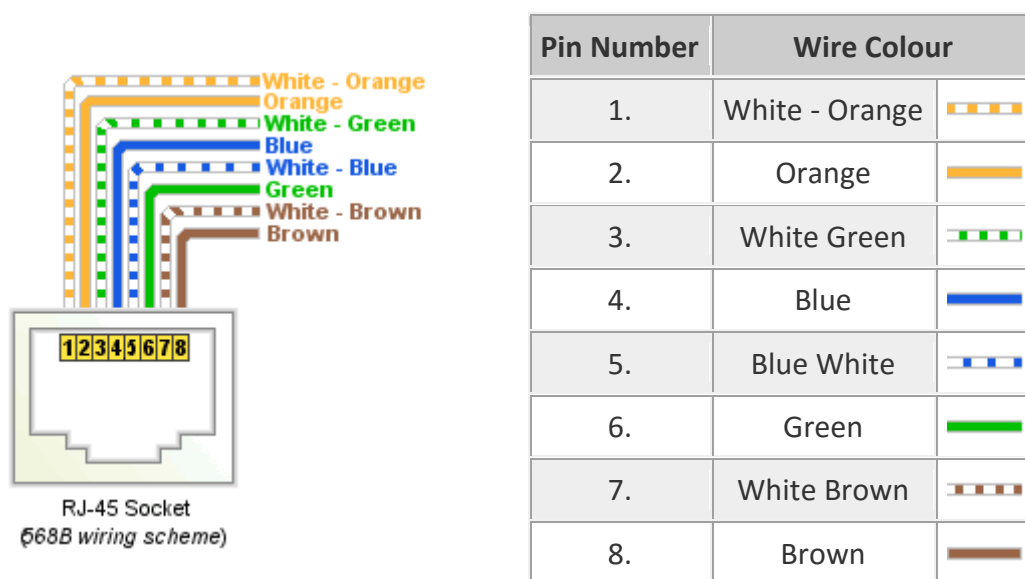


Fig2. EIA/TIA 568B Network Wiring Scheme

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
- **Labeling the cables:**
 - 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 through 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) Networkable PAVA system - EN54 -16 :

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 data and digitised audio signals even over large distances. The system can be expanded even with Fiberoptic links as required using network components.

4) Digital microphone consoles with direct LAN connection

- 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 °C to +55 °C (+23 °F to +131 °F)

Storage temperature: -40 °C to +70 °C (-40 °F to +158 °F)

Relative humidity: 15% to 90%
Air pressure: 600 to 1100 h Pa.

3. IP Paging Console:

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 ATEIS 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.

Table top microphone consoles:

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 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 °C to +55 °C (+23 °F to +131 °F)

Storage temperature: -40 °C to +70 °C (-40 °F to +158 °F)

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 be 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 °C to +45 °C

Storage temperature -25 °C to +85 °C

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 through 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 °C to +55 °C

(+23 °F to +131 °F)
Storage temperature -40 °C to +70 °C
(-40 °F to +158 °F)
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 $\pm 15\%$, 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 °C to +55 °C (+23 °F to +131 °F)

Storage temperature -40 °C to +70 °C (-40 °F to +158 °F)

Relative humidity 15% to 90%

Air pressure 600 to 1100 h Pa.

1.1 Equipment Racks - General

1.1.1 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.

1.1.2 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.

1.1.3 Rack Light Units(Optional)

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.

1.1.4 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.

1.1.5 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.

1.1.6 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.

1.1.7 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.

1.1.8 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.

1.1.9 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.

1.1.10 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.

1.1.11 Blanking Panels

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

1.1.12 Labelling

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

1.1.13 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°C
Dispersion angle (-10 dB):	180° (H) / 180° (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°C
Dispersion angle (-10 dB):	180° (H) / 180° (V)
Mounting:	Quick fit mounting
Type	RCF –PI-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°C

Dispersion angle (-10 dB):	360° (H) / 360° (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°C
Dispersion angle (-10 dB):	140° (H) / 140° (V)
Protection Class:	IP 66 certified +SALTWATER RESISTANT
Mounting:	"u" mounting Bracket
Type	ATLASSOUND AP30T

End Of Section

IP Intercom System Specification

Integrated Security Audio System for Building Security



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GENERAL

WORK INCLUDED

- A. Furnish and install a complete security communication system as described herein and shown on the plans. The system shall include all servers and all necessary boards, power supplies, master control stations, substations, receptacles, special mounting boxes, loudspeakers terminal boards, cable, connectors, and accessories for a complete operational communication system.
- B. Scope of work shall include the on-site SECURITY COMMUNICATION SYSTEMS, including all intercoms, with access to audio paging, the telephone system, CCTV video switchers, alarm systems and access control security systems as shown on the plans.
- C. The Security Communication System shall be able to be operated as part of the IT operation system including support for:
 - Network monitoring servers (SNMP, Syslog)
 - Network time servers
 - E-mail notification of alarms or call requests
 - Remote system programming
 - Remote system upgrade
- D. System shall be capable of adding optional features, capacity, equipment and interfaces listed in the specifications, even if not initially included or shown on the plans.

(Note to specifier: Indicate exact scope of work)

CONTRACT DOCUMENTS

- A. All equipment and work specified in this section shall comply with all the General Conditions of the specifications, contract documents, and drawings as indicated.

RELATED WORK

- A. Systems shall be installed by a qualified Security Communications Contractor, who shall coordinate all work with other contractors and trades.
- B. All necessary conduit, raceways, pull boxes, standard boxes, (and special boxes provided by intercom manufacturer), shall be installed by the electrical contractor.
- C. Installation of the communication systems shall be coordinated with the installation of other related systems such as: CCTV video switching, audio paging, access control, two-way radio, alarm and telephone systems.

(Note to specifier: Indicate other related systems)

QUALITY ASSURANCE

- A. All equipment shall be new, in current production, and the standard products of a manufacturer of intercom equipment. Manufacturer shall be certified as complying with the standards of ISO-9001 for quality control.
- B. Manufacturer shall guarantee availability of parts, for a minimum of (_5_) years from date of shipment.
- C. If required, manufacturer shall be able to demonstrate features, functions, operating characteristics and clarity of sound to owner.
- D. System shall be installed by a factory authorized communications contractor with technicians specifically trained on this system.
- E. On-site maintenance and repair service shall be available locally.
- F. System shall allow remote programming. Manufacturer shall have the ability to access and make changes to the system via IP connectivity.
- G. The manufacturer shall have more than 20 years experience with security audio systems, and upon request it shall document comparable installations (and references hereof).
- H. The manufacturer shall, upon request, be able to document the fulfilment of all certifications.

WARRANTY

- A. System shall include a factory warranty that equipment is free from defects in design, material, manufacturing and operation.
- B. Factory warranty period shall be for 12 months from date of shipment.
- C. Installing communications contractor shall guarantee the equipment, wire, cable, and installation for 12 months from date of acceptance.

SUBMITTALS

- A. Shall include an equipment list, data sheets, system description and block diagrams on equipment to be furnished.
- B. Shall include all data necessary to evaluate design, function, quality, and configuration of proposed equipment and system(s).
- C. Shall include technical manual(s) relevant to the installed equipment and user manual(s) related to the use of functions in the intercom system.

SYSTEM OPERATIONS REQUIREMENTS

SYSTEM PLANNING

The manufacturer shall provide an IP Network Planning Guide (see Ref.1 Stentofon, 2006).

SYSTEM INSTALLATION, TESTING AND TRAINING

- A. The system shall be installed by qualified technicians.
- B. Wiring shall be uniform and in accordance with standard for structured cabling system.
- C. All cable runs at the terminal boards, distribution frames and in all junction boxes shall be tagged and identified.
- D. Installation of the Security Communication Servers shall be coordinated with the installation of other related systems such as:
 - Local Area Network (LAN) and external IP network (WAN)
 - CCTV video switching, audio paging, radio paging, access control, two-way radio, alarm and telephone systems.
- E. Directory numbers, feature codes and special programming shall be documented, printed and made available to owner.
- F. System shall be completely tested to assure that the server and all components, stations, speakers and accessories are connected and in working order.
- G. System shall be pre-tested by contractor and certified to function in accordance with plans and specifications.
- H. System shall be tested in presence of owner's representative.
- I. Installation contractor shall conduct up to 4 hours of instruction in use and operation of the system to designated owner representatives within 30 days of system acceptance.
- J. Installation contractor shall conduct up to 4 hours of technical training in programming, troubleshooting and service of the system to designated owner representatives within 30 days of system acceptance.
- K. Contractor shall provide owner with 2 copies of standard factory prepared operation, installation and maintenance manuals.
- L. Contractor shall provide owner with 2 copies of any risers, layouts and special wiring diagrams showing any changes to standard drawings, if required on project.

SYSTEM OPERATION AND USAGE

- A. It shall be possible for owner to print directory number plans for distribution to users.
- B. Manufacturer shall conduct periodic technical training seminars and make them available to those responsible for on-going maintenance of the system.

SYSTEM SUPPORT AND SPARES

- A. On-site maintenance and repair service shall be available locally and within 8 hours of notification for emergency conditions.
- B. The following system spares shall be made available locally within 8 hours of notification:
 - (1) Central server spare parts kit
 - (1) Desk master station
 - (1) Tamper resistant substation
 - (1) Wall master station.

(Note to specifier: Indicate items needed)

SYSTEM OVERVIEW

Introduction

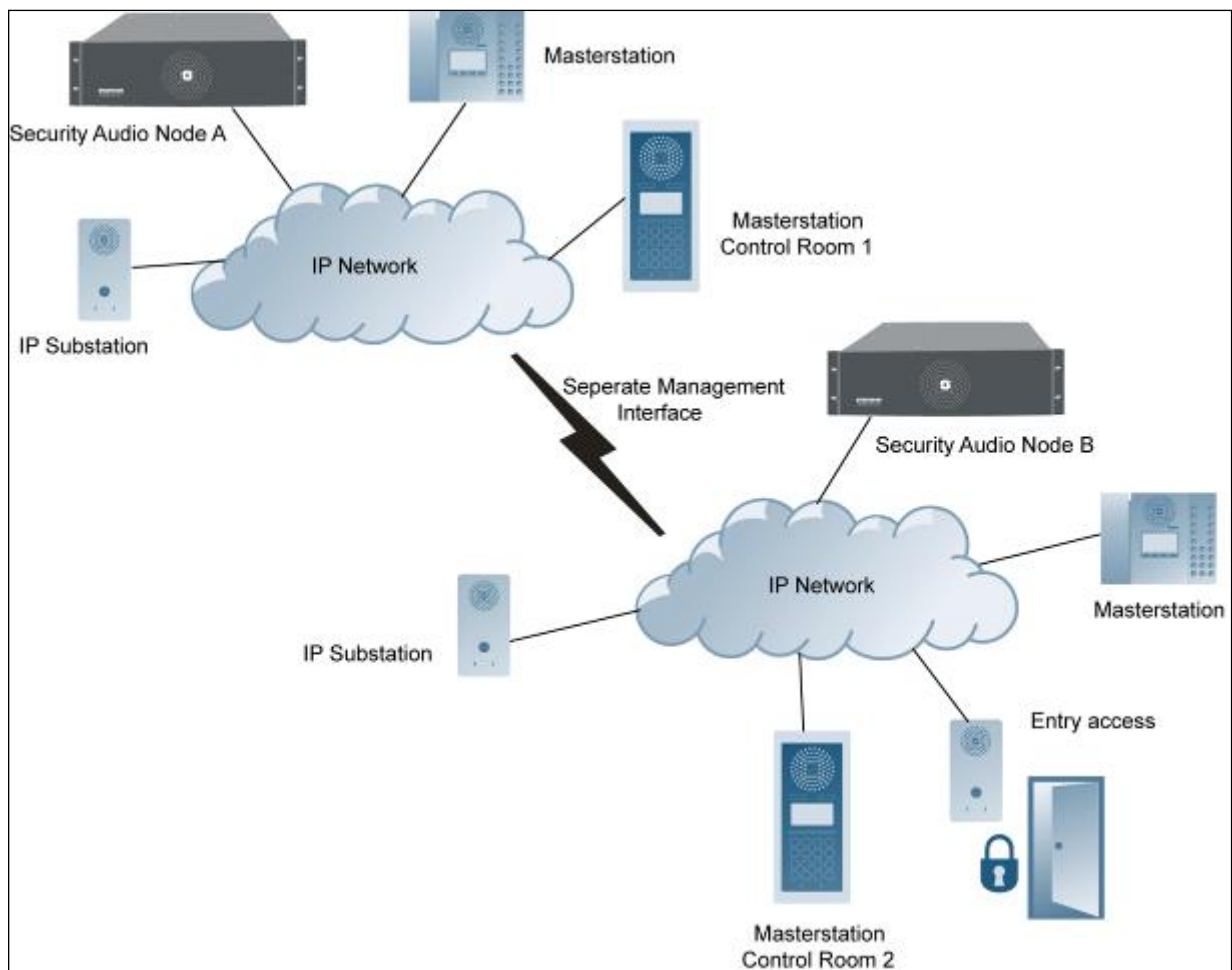


Figure 1 A generic building with Integrated Security Audio Network

The Security Communication System shall be integrated with the (building) security system and provide a network of security voice stations throughout the entire system.

The station type shall be selected according to the purpose of the station and the environment in which it will operate. (An overview of station types and how to specify them can be found in chapter 6)

System Administration

There should be two IP networks, one for the building Security Communication System and one for the IT administration.

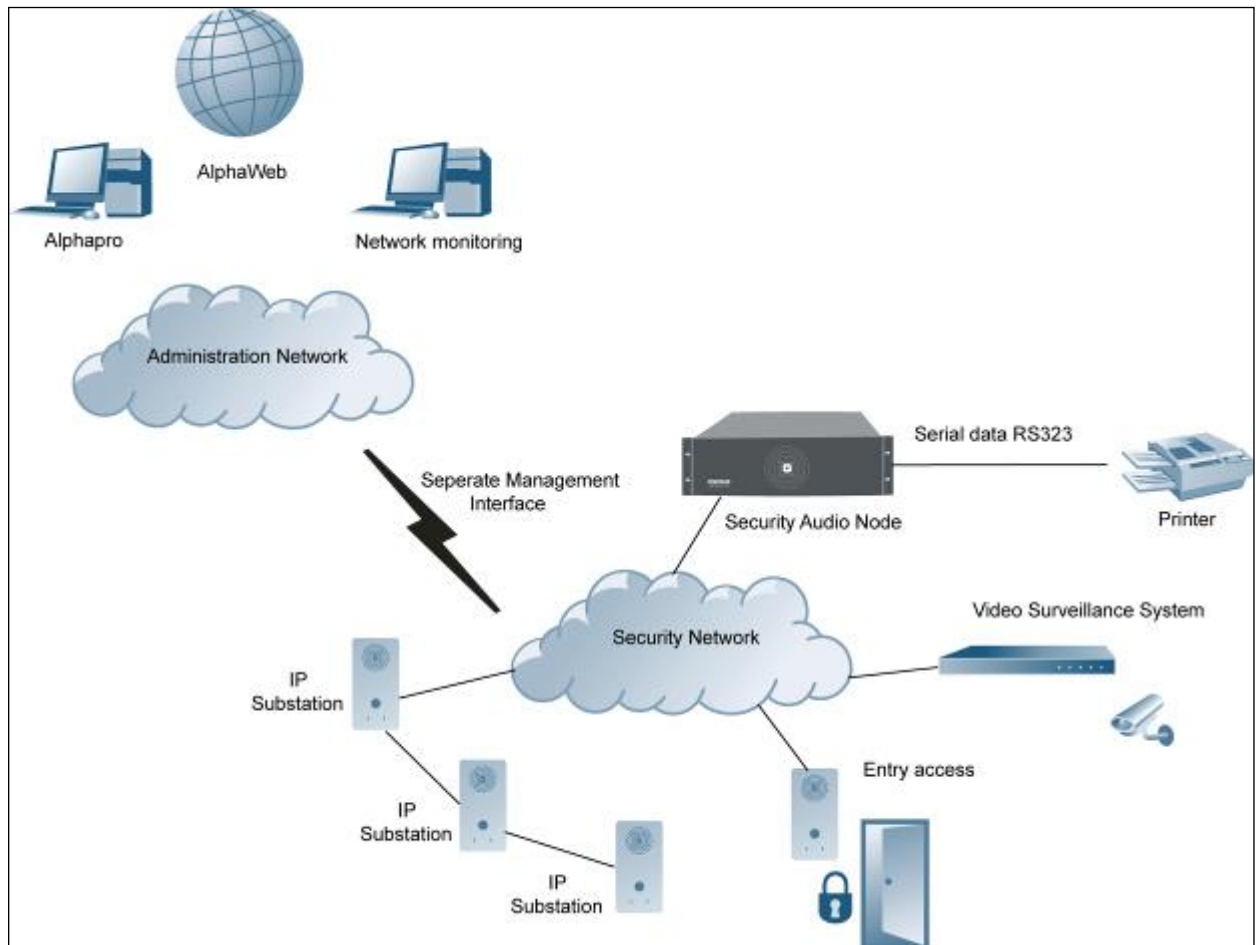


Figure 2 A generic separation of Security Audio network and Administration network

There shall be a dedicated IP network for the building security application (security audio, CCTV, access control, etc.).

This security IP network shall be separated from the other IP networks in the building.

Note!

The supervision and fault handling of hardware is often undertaken by the IT department. That means that if there is a Security Communication System or a station which are not functioning correctly, the IT department will handle the issue. The security functions of the building can then focus on the security application and not whether or not there is a fault in the elements of the system.

The Security Communication System shall have a separate IP management interface, allowing integration to the IT administration network and application.

The Security Communication System shall be able to integrate logging into the IT network monitoring servers by means of SNMP and syslog.

It shall be possible to monitor and log the status of the Security Communication Server and all Audio Stations from the IT administration network by use of standard web-browsers (MS IE, Firefox).

The software on the Security Audio S and all IP Audio Station shall be able to be upgraded using a standard Web-browser.

It shall be possible to configure and program the Security Communication System from the IT administration network.

System Monitoring and Logging

LINE & BOARD TESTING

- A. The system shall automatically test the wiring to legacy station wiring and detect faults within 5 seconds for display stations and within 1 minute for non-display stations.
- B. The system shall automatically test the link to every IP station every 5 seconds and detect a fault within 10 seconds.
- C. The system shall have possibility of periodic tone testing of station – i.e. loudspeaker and microphone.
- D. The system shall have possibility of automatic and periodic board testing.

SYSTEM LOGGING

- A. The system shall provide the following types of log:
 - Statistics and call log.
 - System log.

The system log provides technical events for monitoring the health of the system.
- B. Debugging log.

The debugging log includes low level system events that software engineers and support personnel use for troubleshooting.
- C. The statistics log shall provide an event for each function that is requested and executed by the Security Communication System. This shall include events and information like:
 - Call detail information, including VoIP statistics and time and duration of call.
 - Time and details for all call request.
 - Time and date for all alarm requests.
 - Time and date for all transfer functions.
- D. System log level shall minimum include the following information:
 - Software errors.
 - Hardware errors.
 - Line errors.
 - Alarms.
 - Remote input on/off.
- E. The Security Communication System shall be able to send the different types of log to multiple remote destinations. This destination could be:
 - IT helpdesk.
 - Security control room in the same building.
 - Security control room at remote sites.
 - Monitoring solution responsible for the Security Communication System.
- F. The Security Communication System shall be able to output the log events to:
 - Local file system.
 - Syslog (standard used by main IT network monitoring servers and tools)
 - E-mail
 - SNMP trap (standard used by main IT network monitoring servers and tools).
- G. The system shall be able to perform filtered logging conditioned upon destination (like Alarms only).
- H. The system shall be able to send e-mails based upon certain key-words in the logging information (making it possible to notify Control Rooms or Security Responsibles if specific events occur)

- I. The Security Communication Server shall have a web interface where it is possible to retrieve the local log file as well as search and retrieve in the different log files.
- J. Time synchronization of events among nodes and other systems.
- K. All Security Communication Servers in the network shall get time information from a defined NTP server (Network Time Protocol).
- L. All log events shall be synchronized in time with the central network clock.

Note!

In an IP network a failure in on sub-system can spread across the network in a matter of milliseconds. It is therefore essential to synchronise the clocks on all equipment in order to find what fault that happen first, thus finding what started the failure situation. NTP is able to synchronize the clocks across the network with accuracy less than 10 milliseconds.

SYSTEM MONITORING

The Security Communication System shall provide the following important system status information for monitoring:

- A. General node information
 - Node states
 - HW configuration
 - SW configuration
 - HW identity (MAC address)
- B. Station status
 - List of all stations
 - Status per station
- C. Status internal networking
 - List of node links
 - Status per link
 - Network delay for VoIP node links
- D. Status external VoIP networking (SIP)
 - List of SIP trunks with destination address
 - Number of licenses pr SIP trunk
 - List of SIP users with destination address
 - Status per user
- E. VoIP audio statistics
 - List of VoIP links
 - Connections
 - Packet loss
 - Network delay
 - Other VoIP statistics
- F. The Security Communication Server shall have a Web server where it is possible to read all important system status information.
- G. The Security Communication System shall be able to provide important system information over SNMP
- H. The Security Communication System shall support SNMP MIB II

System maintenance and configuration/programming

- A. The Security Communication System shall have an easy to use configuration and programming tool.
- B. The configuration and programming tool shall have context sensitive online help.

- C. The configuration tool shall be able to connect to the Security Communication System over the IP network.
- D. It shall be possible to perform remote system upgrade of the Security Communication System using a standard Web browser. The upgrade procedure must take less than 2 minutes.
- E. It shall be possible to perform remote system upgrade of all IP stations connected to the Security Communication System.

Note!

An IP environment is a dynamic environment, which requires regular updates of the servers to support the latest technologies.

- F. System configuration and database shall be possible to back-up and restore via a standard Web browser.

INTEGRATION

The Security Communication System shall be configured as a part of the entire Security Management System and provide seamless integration with systems like:

- access control, intrusion detection and alarm systems
- private radio systems (VHF, UHF)
- emergency notification, audio paging and radio paging
- two-way radios, PBX system and public telephone networks
- video surveillance system
- fire alarm systems

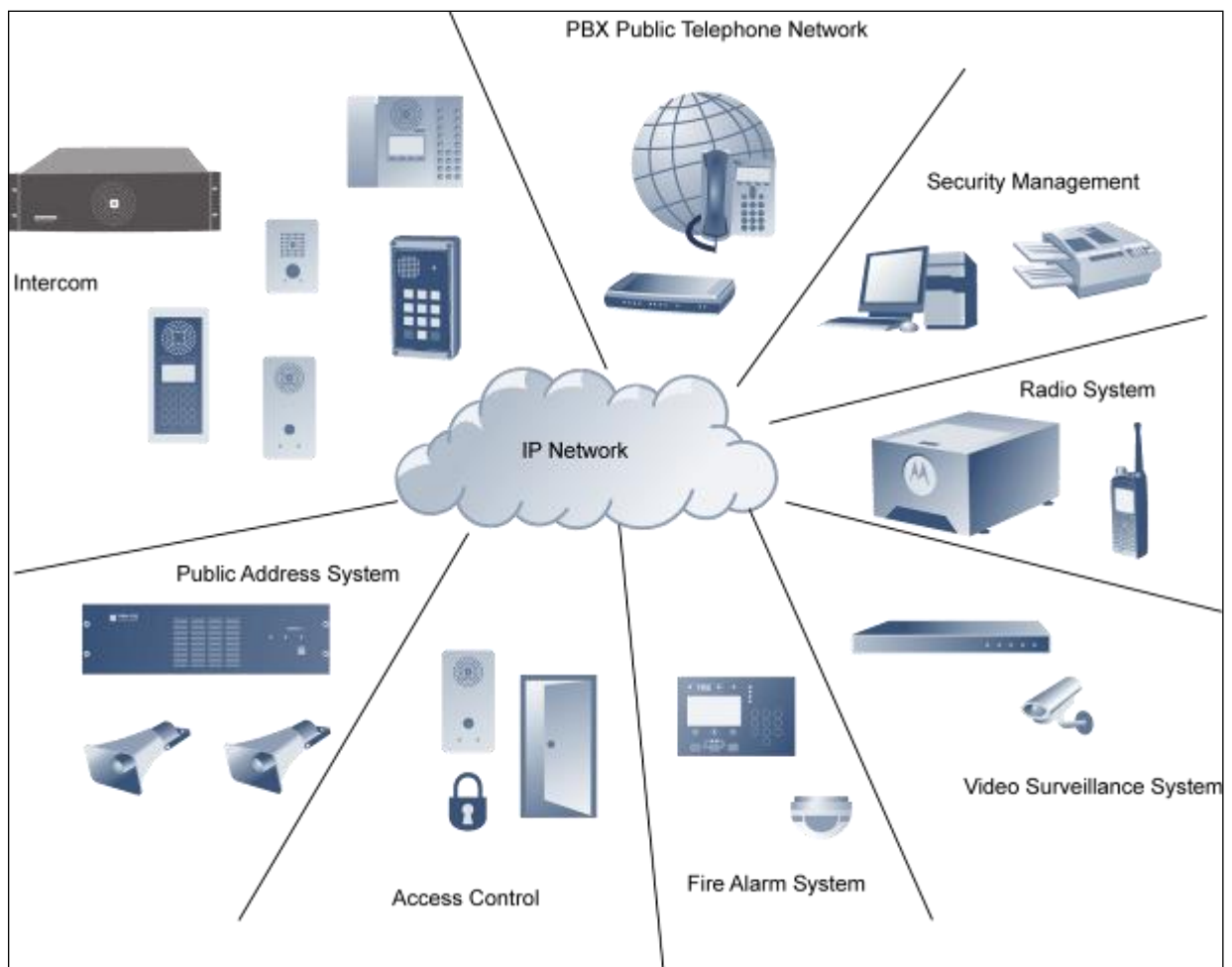


Figure 3 Main Systems for Building Security Management

Integration Technologies

The Security Communication System shall support the following types of open integration points:

- Switches and relays
- Serial data protocols
- TCP/IP protocols

- Analogue audio (0 dB, 600 Ohm)
- VoIP audio and signalling using SIP
- Traditional telephone interfaces (ISDN, analogue & GSM)
- The Security Communication System shall support OPC & SDK

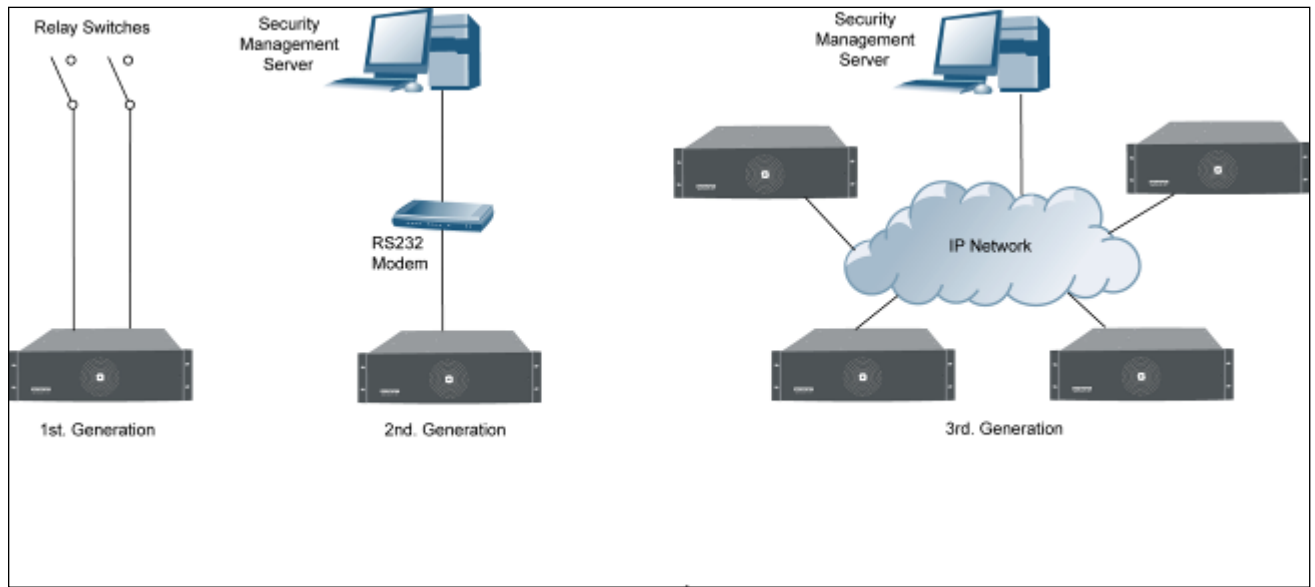


Figure 4 Overview Open Integration Points

Advanced Integration Technologies

The Security Communication System shall support the following types of advanced integration protocols:

OLE for Process Control – OPC

- The Security Communication System shall support Standards based on integration with OPC and Microsoft .Net
- The Security Communication System shall support following OPC Standards : OPC DA V2 (OPC Data Access) OPC DA V3 (OPC Data Access) OPC AE V1.1 (OPC Alarms & Events)
- The Security Communication System shall offer event string in OneLine, Detailed, Short, XML and XMLPretty format.

Software Development Kit (SDK)

- The Security Communication System shall offer integration between AlphaCom XE and system management software based on Microsoft .NET
- The Security Communication System shall provide an SDK to support application software developers.
- The SDK API shall consist of a number of assemblies (DLLs) which can easily be integrated with software written in C# or VB.NET.
- The SDK shall support auto-discovery of complete network configuration and auto-generate the communication server station state data.
- The SDK shall support integration with I/O and relay in the intercom station
- The SDK shall support integration with I/O in communication server modules

- G. The SDK shall support integration with separate I/O and relay units.

Integration with other security systems

FIRE ALARM

- A. The Security Communication System shall be able to integrate with <product name> Fire Alarm System.
- B. The manufacturer shall be able to document installation and references of integration with <product name> upon request.
- C. When a fire alarm is activated, the Security Communication System shall automatically establish a call from the control room to the area where the fire alarm was generated.
The guard can then verify with people in the neighbourhood whether this is a valid fire alarm and the severity of the fire.
- D. The Security Communication System shall be able to use information from the fire alarm detectors to provide safe automatic voice guided evacuation.

CCTV

- A. The Security Communication System shall be able to integrate with <product name> video surveillance system.
- B. The manufacturer shall be able to document installation and references of integration with <product name> or similar product upon request.
- C. It shall be possible to associate intercom stations with the active camera to give the guard a listen or talk option using a single touch button.
- D. It shall be possible for the camera to switch on automatically when the corresponding station is activated.
- E. It shall be possible for the camera to switch on automatically when the corresponding IP station is activated through its voice activity detection feature.

ACCESS CONTROL

- A. The Security Communication System shall be able to interface <product name> Access Control system.
- B. The manufacturer shall be able to document installation and references of integration with <product name> or similar product upon request.
- C. When a door fails to open using an access card and/or access code, the station in proximity to the door shall be turned on and the guard can ask what the trouble is.
The guard shall then be able to open the door by pressing a key.
- D. There should be an intercom substation next to any door access control.
By pushing the substation button, the visitor will make a call request to a guard. The guard shall then be able to be in voice conversation with the visitor by pressing a key. The door can be opened by the guard by pressing a key.
- E. The Security Communication System shall be able acknowledge a call request from a door station by playing an automated voice message.

ALARM MANAGEMENT SYSTEMS

- A. The Security Communication System shall be able to interface <product name> Alarm Management System.

- B. The manufacturer shall be able to document installation and references of integration with <product name> or similar product upon request.
- C. There should be a vandal proof intercom station in locked areas like prison cells etc.
By pushing the station button, the locked-up person will make a call request to a guard. The guard shall then answer the call by pressing a key.
- D. The Security Communication System shall be able to initiate a 'scream alarm' when it is high noise in an area.
- E. It shall be possible to associate intercom stations with alarm calls.
The guard is given a single key touch listen-and-talk option to the area where the alarm was initiated.

Integration with other communication systems

PUBLIC ADDRESS

- A. The Security Communication System shall be able to interface <product name> Public Address System.
- B. The manufacturer shall be able to document installation and references of integration with <product name> or similar product upon request.
- C. It shall be possible to dispatch PA calls from the intercom stations.
- D. The Security Communication System shall be able to interface up to 250 PA zones.
- E. All master stations shall be able to dial or direct access into one, or more, voice paging system(s) for zoned and/or department paging over amplified speakers, unless specifically restricted through programming.
- F. It shall be possible to dispatch pre-recorded voice messages from any station in the communication system, unless specifically restricted through programming.
- G. It shall be possible to record, listen to and dispatch messages from any station in the communication system, unless specifically restricted through programming.

TWO WAY RADIO

- A. The Security Communication System shall be able to interface <product name> Private Radio System.
- B. The manufacturer shall be able to document installation and references of integration with <product name> or similar product upon request.
- C. It shall be possible to set up multiple intercom system to listen to a radio group.
- D. It shall be possible to talk into the radio channels from the intercom stations.
- E. It shall be possible to dispatch calls between the private radio system and the PBX system, the public telephone system as well as intercom stations.
- F. It shall be possible to transfer private radio calls from an intercom station to the PBX and public telephone system.

EXTERNAL TELEPHONE NETWORK

- A. The Security Communication System shall be able to interconnect with a PBX system and the public telephone systems.
- B. The interconnection to external telephone systems shall be done by:
 - Analogue telephone lines (FXO)
 - ISDN BRI

- ISDN PRI
- Session Initiation Protocol (SIP) VoIP trunking
- C. The Security Communication System shall support up to 30 channels to the external telephone systems.
- D. Calling number presentation shall be supported between the PBX system and Security Audio System.
- E. The Security Communication System shall be able to share a private number plan with the external PBX system.
- F. The Security Communication System shall have possibility to undertake SIP-based trunking to Cisco Call Manager PBX.

SYSTEM REQUIREMENTS

GENERAL SYSTEM PROFILE

SECURITY COMMUNICATION SYSTEM PROFILE

The Security Communication System shall be able to provide communications both under normal circumstances and in emergencies (*Ref: Craighead, 2003*).



AlphaCom XE1	AlphaCom XE7	AlphaCom XE20	AlphaCom XE26
Total of 552 Subscribers	Total of 552 Subscribers	Total of 552 Subscribers	Total of 552 Subscribers
	Max 36 Analog Subscribers	Max 80 Analog Subscribers	Max 138 Analog Subscribers

Security Communication Servers in the STENTOFON AlphaCom XE series comply with all specifications in this document.

- A. The system shall support analog stations using 2 pair wiring and IP-based stations using Ethernet wiring.
- B. The server shall be backward compatible with older systems and equipment of the same brand.
- C. The system shall be capable of automatic duplex hands-free operation without the use of handsets, at both the initiating and receiving station.
- D. Calls between IP based stations shall be in full duplex.
- E. System capacity shall include at least one Security Communication Server cabinet wired and equipped for:
 _____ stations/numbers and _____ speech channels. (See details in Annex A.)
- F. Each server system shall be expandable to _____ stations by adding plug-in boards and additional Security Communication Server modules.
- G. The central server shall include at least _____ simplex conference channels, at least _____ programmable group calls per server and _____ global group calls in network configuration.

(Note to specifier: indicate size and capacity of server)

- H. If temporarily blocked, and a high priority call is initiated, the system shall automatically disconnect the call with the lowest priority and setup the call with the higher priority.
- I. The server shall support IP-based audio communication without additional hardware.
- J. There must be an interface between the conventional and the IP network infrastructures in the Security Communication Server.
- K. The Security Communication Server shall be able to connect:
 - Analogue telephones
 - Master stations
 - Dual Display station
 - Substations
 - IP Control Room Station
 - IP substations
 - IP master stations
 - IP DECT Cordless
 - SIP based telephones

Note!

The AlphaCom XE1 server only supports IP stations and SIP based telephones.

- L. The Security Communication System shall allow calls to be instantly connected in loud speaking mode.
- M. The Security Communication System shall allow calls to be presented as a ringing call to be answered by lifting the handset or pressing the M key.
- N. The Security Communication System shall allow calls to be made to ringing group consisting of multiple stations. All stations will ring, allowing the call to be accepted at any station in to the group.
- O. The Security Communication System shall be able to put incoming calls in a queue in one or several guard stations. A call can be transferred or escalated according to importance. When the call is answered, the request will be removed from all queues.
- P. The Security Communication System shall allow group calls on the Public Address System. Group calls begin with an announcement 'Ding Dong', and the operator will use Push-to-Talk to broadcast the message.
- Q. The Security Communication System shall allow Push-To-Talk conference mode for radio systems. Operators will manage their access to the conference using the Push-to-talk key.
- R. The Security Communication System shall support Duplex Conferencing between multiple participants. The users shall not need to use Push-to-Talk keying.

SECURITY COMMUNICATION SERVER – SUBSCRIBER BOARDS

- A. All Intercom subscriber boards shall be identical and interchangeable. Malfunction of one subscriber board shall not affect more than six stations. Malfunction of one wire to a subscriber board shall not affect more than one station.
- B. All Telephone subscriber boards shall be identical and interchangeable. Malfunction of one subscriber board shall not affect more than 12 stations. Malfunction of one wire to a subscriber board shall not affect more than one station.

Note! *The AlphaCom XE1 server does not support the subscriber boards.*

CAPACITY OF SECURITY COMMUNICATION SERVER

Hardware Capacity

- A. The Security Communication Server shall have a general processor with minimum 573 MHz frequency.
- B. The Security Communication Server shall have 2 media processors (DSP) with minimum 200 MHz frequency and above 1500 MIPS in performance.
- C. The Security Communication Server shall have hardware acceleration for IP packet switching. The server shall be able to switch VoIP packet in less than 2 ms from ingress to egress IP port.
- D. The RAM on the Security Communication Server shall be at least 100 MByte.
- E. The Security Communication Server shall have at least 1 MByte of Non-Volatile RAM that will survive re-start and power outage. Important information such as time, station status, etc, shall be stored in the Non-Volatile RAM.
- F. The FLASH memory on Security Communication Server shall be at least 64 MByte for storing of local log files, software and configuration.
- G. The Security Communication Server shall be able to store its configuration files on a flash memory.
- H. The Security Communication Server shall be able to import configuration files from a flash memory.
- I. The Security Communication Server shall be able to store up to 10 MB for audio messages on flash memory.
- J. PROM memory shall not be used for storing software or configuration.

Note!

An IP environment is a dynamic environment, which requires regular updates of the servers to support the latest technologies. A solution with PROM memory would then demand high operational costs.

- K. Hard disk drivers (HDD) shall not be used for storing audio, software and configuration files.

Note!

HDD has moving parts and a normal life length of 3 years.

Call and Subscriber Capacity

- A. The Call Capacity of the Security Communication Server shall be above 10.000 calls per hour.
- B. The phone cards should manage at least 12 telephones per card.
- C. The intercom cards should manage at least 6 intercoms per card.
- D. There shall be an option of additional audio boards which each has a capacity of minimum 6 analog audio channels – configurable as input or output.
- E. There shall be an option for additional Input/Output boards in the Security Communication Server with at least 8 remote control inputs and 8 remote control outputs.
- F. The Security Communication Server shall have at least 2 serial ports
- G. The Security Communication Server shall have at least 2 Ethernet ports.
- H. The Security Communication Server shall have a capacity of up to 30 channels for interconnection to other Security Communication Servers.
- I. The Security Communication Server shall have a capacity of up to 30 lines for interconnection to legacy PBXes.
- J. The Security Communication Server shall have a capacity of up to 552 IP Intercom stations without the need of any additional hardware.

Note!

The AlphaCom XE1 server only supports specifications A, E, F, G, H, I & J

NETWORKING

NETWORKING BETWEEN SECURITY COMMUNICATION SERVERS

- A. The total system (x number of Security Communication Servers and stations / phones) shall easily be networked up to 254 nodes / sites.
- B. The communication (signalling and audio communication) between the nodes shall be able to take place on IP network with private or public IP addresses, or a mix of the two.
- C. Each Security Communication Server in the network shall have support of E1/T1 and IP infrastructure for networking.
- D. All features of the Security Communication Server shall be operational across the total network.
- E. High Priority calls shall release lower priority calls if all channels are occupied.
- F. The Security Communication Server shall not delay any audio flow through itself with more than 5 ms when it is serving as a transit switch.
- G. Alternative routing of calls shall be supported.

CLUSTERING OF SECURITY COMMUNICATION SERVERS

- A. It shall be possible to set-up up to four Security Communication Servers as a server cluster in order to add more capacity for more legacy subscriber extensions.
- B. The server cluster shall be managed as one server enabling easy configuration and management.
- C. The signalling and audio communication between the Security Communication Servers in the cluster shall go over IP.
- D. All features shall be operational across the Security Communication Server in the cluster.

AUDIO FUNCTIONS

- A. Every speech channel shall include compression circuits to automatically control and limit sound volume, audio distortion and clipping during conversation.
- B. Audio power output to each station shall be adjustable up to at least 1 Watt.
- C. Frequency response for both input and output shall be a smooth curve through the audio range of:
 - 200 - 10,000 Hz for intercom
 - 200 - 15,000 Hz on audio program channel.
- D. Crosstalk shall be less than:
 - -80 dB @ 1000 Hz, and
 - S/N ratio shall be 60 dB during conversation.
- E. Audio technology used across a network shall support:
 - Wideband 7 kHz (G.722),
 - Narrowband 3.4 kHz (G.711)
 - Utilize Adaptive Jitter Buffers
 - Utilize Adaptive Time Synchronization.
- F. Audio technology used internally in the Security Communication System shall support:
 - High-Resolution 1-bit audio,
 - Hi-Fi 40 Hz - 18.5 kHz,
- G. All IP Intercom Stations shall provide active noise cancellation.

IP SERVICES AND SECURITY

IP services and security for audio server

- A. The Security Communication Server shall have two independent IP network (Ethernet) ports, in which one can be used as a separate management interface and one can be dedicated to the building security IP network.
- B. The Security Communication Server shall not provide IP forwarding between the two IP ports.

Note!

If IP forwarding is enabled between the two IP ports, the node will be a backdoor between the two networks, breaking standard security rules.

- C. The Security Communication Server shall have a built-in firewall to prevent external attacks.
- D. The Security Communication Server shall have a built-in web server which is protected by a login procedure.
- E. Software packages that are installed in the Security Communication Server shall be verified with a digital signature in order to prevent downloading and installation of tampered software and reducing risks of viruses.
- F. The system shall at least support the following IP standards:
 - IPv4 Internet Protocol version 4
 - TCP Transmission Control Protocol
 - UDP User Datagram Protocol
 - SNMP Simple Network Management Protocol
 - Syslog System logging
 - HTTP(S) HyperText Transfer Protocol
 - XML eXtensible Markup Language
 - NTP Network Time Protocol
 - SIP Session Initiated Protocol
 - RTP/RTCP Real Time Protocol / Real-time Transport Control Protocol
 - DiffServ Differentiated Services
 - IP ToS IP Type of Service

IP services and security for IP Intercom Station

- A. The IP stations shall have a built-in firewall to prevent external attacks.
- B. The IP stations shall have a built-in web server which is protected by a login procedure.
- C. The IP stations shall support the IEEE802.1X authentication mechanism for authorized access to data networks.
- D. The Integrated IP switch inside the IP Stations shall be a managed data switch supporting VLAN (IEEE 802.1Q)
- E. The Integrated IP switch inside the IP Stations shall support the Spanning Tree and Rapid Spanning Tree protocols

STANDARD SYSTEM FEATURES

- A. **MASTER CALLS.** A call shall be placed from any master station to any other station in the system, unless specifically blocked, by dialing the appropriate number of the desired station, or using one of the direct access buttons. Either party can cancel call by pressing the (C) button.
- B. **SUBSTATION CALLS.** Each substation shall be programmed to call a specific master station(s). Pressing button on substation shall provide call request verification by blinking LED on station and giving voice message. A substation "call-request" call shall be identified on a display master, with text message, or flash an associated LED and sound a unique tone on a CRM type control room master.

- C. **DIRECT ACCESS BUTTONS.** All desk master stations shall include (10) direct access buttons, programmed for direct access calling, to allow single button speed dialing of other stations, features or telephone lines. Station user shall easily program direct access buttons at any time. Control room masters (CRMIV & CRMV) shall have button modules available in (48) direct access button size with each CRM station capable of up to 96 direct access buttons. Dual Display Master Stations (7007) shall be capable of up to 90 direct access buttons.
- D. **ALL-CALL.** All master stations shall be able to initiate an all-call page to all other stations in the system. It shall be possible to remove stations, through programming, from receiving all-call and restrict any station from initiating an all-call. All stations shall receive all-call announcements at full volume, regardless of station volume setting.
- E. **GROUP-CALL.** All master stations shall be able to initiate selective paging to predetermined groups of stations in the system. Ability to initiate group call shall be restricted to designated stations. A station may be programmed for membership in several groups. It shall be possible to program up to 250 groups. There shall be no limitations to the number of stations in any group. It shall be possible to program up to eight adjacent stations out of a group call so as to eliminate audio feedback. It shall also be possible to record, listen to and dispatch a voice message to eliminate audio feedback. The system shall be able to send out several group calls simultaneously. With up to 4 levels of priority. Each group shall be able to program one of 4 call announce chime tones.
- F. **OVERHEAD PAGING.** All master stations shall be able to dial or direct access into one, or more, voice paging system(s) for zoned and/or department paging over amplified speakers, unless specifically restricted through programming.
- G. **AUTOMATIC SEARCH FEATURE.** Each station shall have a pre-programmed list of actions that can automatically take place when their station is called but they are either busy, private, absent or unattended call request. System shall allow call to be automatically rerouted to another station, call request, group call etc. Each station can have up to 3 different search call numbers. System shall allow manual rerouting by pressing a key during conversation.
- H. **REPLY FEATURE.** A person hearing a page or group call shall be able to begin an immediate normal hands free conversation with the person who initiated the page, by simply pressing an answer code, 99, on any convenient master station in the group. System shall allow multiple page/reply functions simultaneously. The waiting time shall be programmable.
- I. **DUPLEX/MANUAL OPERATION.** Once call connection is established, normal conversation shall take place in the voice switched "duplex" mode, whereby each person may talk "hands-free." Each master shall have a manual "M" button that when used shall control the direction of the conversation (press to talk, release to listen). Momentarily depressing "M" button shall restore duplex mode. Calls between IP based stations shall be in full duplex.
- J. **REMOTE CONTROL FUNCTIONS.** Each station port in the server shall include (1 RCO (Remote Control Output) to be freely used for control of external equipment. AlphaCom Relay Board 99702 required. See Options. Every IP station shall have a built-in relay to be freely used for control of external equipment
- K. **VOLUME CONTROLS.** The volume of each station shall be adjustable by programming the appropriate subscriber board in the server, either from the station or from PC programming. In addition, each master shall have an adjustable slide-switch volume control. Adjustments shall allow a total range of: (-14 dB to +16 dB). Outgoing volume shall be automatically increased by +6 dB when using the M key for press-to-talk.
- L. **TONE SIGNALS.** All features and functions such as: off hook, call connection; busy; call forward; all call; group call; etc., shall be accompanied or preceded by a distinguishable tone. All/Group Call tone signals shall be programmable, and tones shall be harmonic and undistorted. It shall be possible to customize and change the length and frequency of All/Group tones.
- M. **MICROPHONE MUTE.** During a conversation, a person shall be able to momentarily block the microphone on any master by holding down one button (the "0" key).

- N. CALL HOLD, INQUIRY & TRANSFER. Once a call is connected, it shall be possible to place the call on "hold" by pressing one button (digit #2), dialing and conversing with a third party, switching back and forth or transferring the call by pressing one button (#3).
- O. STANDARD CONFERENCE. It shall be possible to establish and/or join a conference by dialing a four-digit code. It shall be possible to include any number or all stations in a conference. The system shall be capable of 50 conferences. Voice control shall be manual, (press-to-talk, release-to-listen). In a standard conference, intercom and paging announcements shall temporarily interrupt the conference. One person at a time shall talk in an individual conference. Stations can be programmed with the ability to override and take control of talking into or feeding the conference.
- P. PRE-SET GROUP CONFERENCE. It shall be possible to set up a group conference by simply dialing a two-digit code, then a group number followed by the conference number. System shall allow up to 50 conference groups. Dialing the pre-set group conference number shall include all members of the group, and all members of the group shall be able to hear whoever is talking. Each group member shall be able to speak to the group by holding down the [M] button on his master. It shall be possible to have a pre-set conference automatically activated by a remote alarm contact. One person at a time shall talk in an individual conference. Certain stations can be programmed with the ability to override and take control of talking into or feeding the conference.
- Q. DUPLEX CONFERENCE. It shall be possible to set up a hands free duplex conference by simply dialing a four-digit code. It shall be possible to have 20 different conferences. It shall be possible to start a preset duplex conference to include a preset group of stations. It shall also be possible to program DAK Keys on stations to allow for single button dialing to enter conference and also start a preset conference. The duplex conference shall be able to include up to 16 members.
- R. PRIORITY AND CLASS OF SERVICE. System shall have 4 levels of priority to allow or deny access to features, such as voice or pocket paging, all-call, group-calls, preset conferences, tie-lines, telephone lines, special interfaces, groups of stations and text display of alarm messages. System shall include 16 classes of service which shall allow the ability to customize features/functions available to stations.
- S. DO-NOT-DISTURB. All master stations shall be equipped with a privacy/open switch to permit any user to put his station in the "privacy" mode. When in the privacy mode, an incoming call shall sound a unique "privacy ring tone" at both the initiating station and station being called. Call may be answered by pressing the "M" button. It shall be possible to program selected stations with "Privacy Override", whereby calls will be heard even if stations are in the privacy mode.
- T. STATION NUMBERING. System shall have a true flexible numbering plan feature, whereby any number from "0" to "99999999" may be assigned to stations or feature codes. Dialing between remote servers shall be transparent. Shall be factory programmed with an "autoload" numbering plan of up to 650 separate numbers that may be changed on-site as required. It shall be possible to change numbers any time through programming, with access codes, without any rewiring.
- U. MUSIC DISTRIBUTION. System shall allow up to 6 channels of music to be distributed to all stations. Each master may select a desired channel by simply dialing a three-digit code. Music shall be interrupted during intercom calls and return automatically upon completion of the call. System shall also include a "channel step" function. Thirty-two additional channels shall be available through optional boards.

Note!

- Standard for AlphaCom XE7 is two channels. Optional board 9301 APC Filter Connection Package must be used for AlphaCom XE20 and XE26.

- Note to specifier: Indicate if music distribution is required for system.

- V. INFORMATION CHANNEL. System shall allow one or more audio channels to be programmed to distribute audio information that is pertinent to the operation of the facility. Channel shall be accessed and operate as described for music distribution.
- W. REMOTE SET UP OF PROGRAMS. It shall be possible to individually program stations, or groups of stations to receive a channel from a remote master control station.

- X. TEXT MESSAGES. The system shall allow multiple alpha/numeric text messages to be stored in queue on each master. The sequence of display shall be based on the priority of each message. System shall include (9) absent, (9) functional and (3) alarm messages.
- Y. TECHNICAL ALARMS. It shall be possible to activate a preset (16) character text message on a selected display master, group of masters or activate an audio message on the information channel, from remote alarm contacts. Each message can be customized and set with a priority level through programming. The system shall include (6) inputs for technical alarms.

Note!

- Standard for AlphaCom XE7 is two inputs. Optional board 9301 APC Filter Connection Package must be used for AlphaCom XE20 and XE26.

- Z. AUDIO ALERT OF TEXT MESSAGE. System shall allow (3) types of audible alert tones to sound at the master, when messages are activated. Shall also allow connection of external alarm indicators (lamps, buzzers or bells) to sound for high priority messages in noisy environments.
- AA. CALL REQUESTS TO MULTIPLE MASTERS. It shall be possible to program up to (20) masters to simultaneously receive and display text message call requests from substations. When the calls are answered at one master, the messages shall be deleted from all other masters. It shall also be possible if receiving a call request with a certain high priority level to alert receiving station(s) by a private ringing tone.
- BB. TRANSFER OF CALL REQUESTS. It shall be possible to transfer call requests from substations (while allowing standard calls) to different masters by simply dialing a (4) digit transfer code plus the number of the master or group of masters that will receive the transferred calls.
- CC. TRANSFER OF STANDARD CALLS. It shall be possible to redirect (Call Forward) "all" calls to another master, a pager number, telephone number, or group number simply by dialing a two-digit code 71, plus the redirected number. When in the "transferred" mode, only the station selected to receive the diverted calls shall be able to call or transfer calls to the forwarded station. It shall also be possible to redirect calls while at the receiving station (Follow me) by dialing a two-digit code 72 plus the number of the forwarded station. The system shall be able to simultaneously handle up to (100) call forward commands.
- DD. "CAMP-ON" BUSY. The system shall include ability to call a busy station, or feature, hear a busy tone (reduced in volume after 5 seconds), wait for a preset time and automatically connect when the called station or feature is free. Upon connection, both parties shall hear the normal "connection tone." Number of "camp-on" calls in the system shall be unlimited.
- EE. TEXT CALL BACK MESSAGE. If the calling party does not wish to remain "camped-on," it shall be possible to place the call in memory and display a callback message on the called party's station by dialing an additional digit [8]. The message shall be registered on the display. It shall be possible to leave up to 9 pre-set text messages on the display of the called station. The number of "call-back messages" on any one station, or in the whole system, shall be unlimited.
- FF. VOICE CALL-BACK MESSAGE. It shall be possible to leave a "pre-set" audio voice message, by dialing a voice message code 7 on the initiating intercom station. The audio message shall be played back at the receiving station by dialing two digits 70. Voice messages shall require 9304 ASVP board in the server (see options)
- GG. GROUP HUNT. The system shall allow programming of multiple "Hunt" groups, whereby calls to a group number will search and connect to the first available station in the group. The feature may be programmed to have a rotational or fixed start point. Feature shall allow substation calls to be directed to a primary master but if it is busy, search for an available master in the group. Shall allow automatic transfer on busy
- HH. SOFTWARE PROTECTION. All programmable information, including customer on-site changes, shall be retained in FLASH memory. In addition, it shall be possible to store the program on a PC using a configuration tool and also be able to download via the web interface the contents of the FLASH memory as a file for backup.

- II. EMERGENCY ALARM CALLS. Selected stations shall be able to initiate priority alarm calls to groups of stations in the system. Alarm calls shall override all conversations in progress, override station volume settings, and be heard even if handset is off-hook on desk master stations. Stations can be exempt from receiving the emergency calls. In addition, it shall be possible to initiate an alarm call from external equipment and give an automatic voice message.
- JJ. WAKE UP REMINDER CALLS. The system shall allow (200) separate automatic date and time calls that will cause individual stations to ring at preset times. This wake up time is entered at the selected station itself. The duration and number of rings shall be programmable. After initiation, dialing a digit or lifting the handset shall cancel the ring.
- KK. FAULT/ALARM LOGGING. System shall archive via Syslog file fault conditions within the system (faulty boards, wiring or software), and external alarm conditions input through the intercom system (prints time and source of alarm) as well as call logging between intercom stations for the entire system. It shall also be possible to view via AlphaWeb the Syslog file to inspect the contents of the file. Using an OEM Syslog viewer shall allow for faults/alarm logging and call logging events to be sent to remote/external IP address for remote monitoring of the system and also the possibility to send these events via Syslog viewer to an email address.
- LL. ALARM OVERRIDE. System shall allow priority calls and voice alarm messages to override standard intercom calls and come through speaker at full volume, even when handset is in use, privacy switch on and volume set low.
- MM. TONE TEST. System shall have the capability to do a tone test of entire system. This tone test shall test the speaker and microphone circuits of all standard stations. This test can be performed automatically everyday at a certain time or can be manually started to provide a system evaluation for troubleshooting purposes. The results of the tone test are sent to Syslog file and are saved so results can be looked at a later time that is convenient via AlphaWeb.
- NN. HOTLINE CALL. System shall have the ability from any master station to perform a hotline call. This hotline call is performed by lifting the handset on a master station, which in turn will place a call to a station or feature that is programmable per station in 5 seconds. Default timer of 5 seconds is programmable, however this is a system wide timer for all stations.
- OO. EVENT HANDLING. Programming of custom scripts allows for custom software functions or features that are not provided in the basic system. These special features can include actions such as ASCII data outputs strings to external computers for interfacing to CCTV or card access or specific events related to transfers, call requests to multiple stations in multiple servers simultaneously and many other non standard features that a customer desires that are unique to or needed for their intercom system.
- PP. SIP INTERFACE. This interface shall provide the ability for VoIP telephones or telephone systems which support SIP protocol to interface and register to the AlphaCom XE-series server. VoIP telephone can be a single IP telephone device or can be a soft phone client running on a PC. This interface allows for point to point calling between any intercom station and SIP telephone devices with call number and text shown on both ends of the call. Requires #9643-XXX SIP license(s) which is dependent on the number of SIP users required. IP SIP capable phone by others, consult Zenitel for recommended models that have been tested for use with the AlphaCom XE system.

(Note to specifier: Indicate if SIP Protocol is required for system.)

- QQ. ACTIVE NOISE CANCELLATION. Shall be provided at the audio edge device. IP stations shall use an advanced signal processing algorithm to identify and filter out background repetitive noise signal audio. The feature shall be integrated into the IP station onboard DSP and software adjustable from the IP station integrated web server.
- RR. IP NETWORKING AND SECURITY. Shall be provided at the audio edge device. IP stations shall have the IEEE 802.1X standard for port-based Network Access Control which provides an authentication mechanism to devices that need to attach to the LAN. It either establishes a point-to-point connection on authentication or it prevents such a connection if the authentication fails. IP stations now have a managed data switch supporting VLAN which allows single network connection to be shared for the IP

station and IP CCTV camera without disrupting service quality or violating security. IP stations also shall support the spanning tree and rapid spanning tree protocol.

CONTROL ROOM SYSTEM OPERATION

- A. MASTER-TO MASTER CALLS. All masters shall be able to call all other masters individually, point to point, unless blocked through programming, by simply touch dialing a 1-8 digit number, or by using direct access buttons. Once dialed, both stations shall be able to converse "hands free". All standard features listed shall be available to all masters.
- B. CALL FROM SECURITY SUBSTATION TO CRM MASTER. A call request shall be initiated from a substation by activating an alarm button, or the call-in button on the substation. The call request shall indicate to the calling party with a flashing green LED (and an audible call acknowledgment voice message) to comply with ADA (see options). It shall be possible to also start an external strobe light (see options). This call request shall be annunciated at the CRM Control Room Master station as follows:
 - 1. The LCD will show you have received a call request from a station.
 - 2. A rapidly repeating tone signal sounds. Call request shall be answered at the CRM by pressing appropriate direct access button preprogrammed to answer all call requests from stations.
 - 3. When call is answered the following shall occur:
 - a. A connection tone is heard at both the CRM and the calling station.
 - b. Flashing green LED illuminates "solid" on the appropriate button if direct dial unit (D48) is used.
 - c. The Number and Text of the station that is connected appears in the LCD.
 - d. An in-use LED illuminates on the calling substation.
 - e. Clear, two-way communication shall take place.
 - f. Other calls from substations to the CRM station shall each flash their appropriate direct access button LED if direct dial unit (D48) is used and sound the call-in tone.
- C. CALL FROM A CRM STATION TO ANY OTHER STATION. A call shall be placed from a CRM station to any other station in the system by simply dialing the station number on the digit keypad. LCD on the CRM station shall indicate the number and text of the called station. When calling any other master station, "duplex" hands-free communication shall be possible between the two stations. When calling an elevator car, or other security substation, the press-to-talk button shall be used to control the conversation, if needed.
- D. GROUP CALL FROM A CRM STATION. A group call shall be initiated at a CRM by dialing the number assigned to preprogrammed group of stations. This shall sound an alert tone and allow paging to all stations in the group. There shall be no limitation to the quantity of stations in a group. Group calls shall have priority over other conversations in progress.
- E. PROGRAMMING BUTTONS ON THE CRM STATION. Direct access buttons on the CRM master station shall be easily programmed and changed by the station user. Once programmed, the button assignments shall remain in memory. This feature is valid if CRM is equipped with D48 button modules.

REQUIREMENTS OF DAILY SECURITY ROUTINES

The system shall support the following daily security routines:

- A. Transfer of responsibility from Guard Station to Central Control Room:
 - Shall be done by simple button-pressing on Master Station.
 - Shall let all calls go to Master Station in Central Control Room.
- B. Transfer of responsibility from Central Control Room #1 to Central Control Room #2 (for example by time of day or weekend).
 - Shall be done by simple button pressing on Master Station
 - Shall be done by pressing of buttons on web interface

- Shall be possible by auto transfer at fixed times, controlled by the real time clock of the server
- Shall be possible to forward unattended calls after a preset time
- C. Simple analysis of alarms every 4 hours.
 - It shall be possible to print and read directly all alarms for the last 12 hours.

(Note to specifier: Describe other desired operations)

EQUIPMENT

STATION Types

MASTER STATIONS

Master stations give full access to all the features provided by the communication system. Every master station features a full keypad to dial any station connected to the network. Most master stations are equipped with a handset in order to have private conversations. Most master stations also support a OPEN or PRIVATE mode, which allows the user to choose to be dialed up before establishing a conversation. Masters stations also feature Direct Access Keys (DAK). These keys are preconfigured by the user or system administrator as direct call buttons or to execute certain tasks such as (de)activating a light or electric door lock.

Depending on the use and environment several master station types are available:

Default Master Station: Used in an administrative environment or as control room station in small scaled systems. The stations are available with or without handset and with or without display. This station is available in analog or IP version.

Wall/Flush Mount Master Station: This station has the same features as a default master station but can either be wall mount or flush mount. Additional features such as gooseneck microphone and handset are available. This station is available in analog or IP version.

Industrial Master Station: This type of station is used in environments with high exposure to dust, sand, heath, water, etc. Most of these stations have a high IP-class rating. The stations have an external loudspeaker to deal with the high level of noise and are available with or without handset.

Control Room Station: This is an upgraded version of the Wall/Flush Mount Master station. It is expanded with one or two DAK modules which features 48 additional buttons per module. The station is used in large control rooms to efficiently run the operation of the communication system.

IP DECT Station: This is a portable intercom station interfaced with the communication server over a SIP interface. It offers some of the features of the default master station and is available for an office, industrial and ATEX environment.

SUB STATIONS

Sub Stations have one call button and dial a preconfigured extension. Some substations are available with two buttons to dial two extensions. They are often used at doors to add extra security to the access control system but they play an important role as a “help point” in providing emergency communication in case of crisis. The same station can also be used as an “information point”.

Depending on the use and environment several master station types are available:

Weather Resistant and Vandal Proof Sub Station: These are mainly used outdoors and are resistant against vandalism and severe weather conditions. They serve a purpose as help or information points as well as adding extra security at an entry point.

Tamper Resistant and Vandal Proof Sub Station: This type of station is used mainly indoors in areas with a high exposure to vandalism. The station plays a crucial role in providing additional security. It is commonly used in correctional facilities to provide extra security to the staff and the detainees but also to the visitors. The more advanced model will provide additional functionalities such as music broadcasting, light signaling and scream alarm.

Industrial Sub Stations: This type of station is used in environments with high exposure to dust, sand, heat, water, etc. Most of these stations have a high IP-class rating. The stations have an external loudspeaker to deal with the high level of noise and are available with or without handset.

STATIONS

IP DESK MASTER STATIONS

- A. Master stations shall have access to all features in the server.
- B. Master stations shall include the following controls:
 - Dialing buttons 0-9 + # and *
 - Manual "M" button for speech control and other functions
 - Cancel "C" button
 - Variable volume control.
- C. Shall include 10 true direct access buttons; subsets or multiple keystrokes shall not be acceptable.
- D. The station shall be in a modern white plastic housing, suitable for desk (or wall) mounting.
- E. The station shall have a handset for confidential conversations.
- F. Station shall include a large high contrast display with backlight which allows important information about connections to be shown.
- G. Shall include a red "Station-on" LED.
- H. Shall be 1.5 Watt audio output and 85 dB audio pressure 1 m from speaker
- I. The station shall support a two-port 10/100 Mbps Ethernet switch of which one Ethernet port shall be used to connect to a PoE switch over an Ethernet cable (Cat 5 or Cat 6). It shall be configured with fixed or dynamic IP-addresses.
- J. The station shall connect directly to IP networks and have an integrated web server for easy configuration, monitoring and remote automatic software updates.
- K. Frequency response of input and output shall be 200 to 7000 Hz.
- L. The station shall provide wideband audio. The codecs are either standard G.711 or the wideband audio codec G.722.
- M. The station shall use an advanced signal processing algorithm to identify and filter out background repetitive noise signal audio.
- N. The unit shall tag priorities (DiffServ, ToS) at the Ethernet packets, and shall have acoustic echo cancellation and adaptive jitter buffer.
- O. The station shall be supervised from the IP network, and shall be configured from a central server or by using the integrated web-server.

The following STENTOFON Standard Master Stations comply with the above specifications:



1008000000

Display

168 x 75 x 176 mm

Desk or wall mount



1008001000

Handset + Display

225 x 75 x 176 mm

Desk or wall mount

Note to specifier: Specify station type as desired

ANALOG DESK MASTER STATIONS

- A. Master stations shall have access to all features in the server.
- B. Master stations shall include the following controls:
 - Dialing buttons 0-9 + # and *
 - Manual "M" button for speech control and other functions
 - Cancel "C" button
 - Privacy slide switch
 - Variable volume control.
- C. Shall include 10 true direct access buttons; subsets or multiple keystrokes shall not be acceptable.
- D. Shall include a red "Station-on" LED.
- E. Shall include a 3", 1.6 watt speaker with 88 dB sensitivity, mounted in an acoustic baffle.
- F. Shall include an electret microphone with 100/300 mV output and sensitivity of -65 dB @1 KHz.
- G. Shall include a preamplifier with 1000 ohm output impedance and greater than 40 dB signal to noise ratio.
- H. Frequency response of input and output shall be 300 to 10,000 Hz.
- I. Output power shall be 1 W.
- J. Master stations shall be in a modern grey or black plastic housing, suitable for desk (or wall) mounting, and have a 2 m (6 foot) cord with plug.
- K. Master stations may have a lightweight handset with coiled cord and magnetic hook-switch for confidential conversations.
- L. Master stations may have a two-line, 16 character information LCD display.

The following STENTOFON Standard Master Stations comply with the above specifications:



1007036210

Basic

168 x 75 x 176 mm /
6.6 x 2.9 x 6.9 inch

Desk or wall mount



1007034210

Handset

225 x 75 x 176 mm
8.9 x 2.9 x 6.9 inch

Desk or wall mount



1007036310

Display

168 x 75 x 176 mm
6.6 x 2.9 x 6.9 inch

Desk or wall mount



1007034310

Handset + Display

225 x 75 x 176 mm
8.9 x 2.9 x 6.9 inch

Desk or wall mount



1007071090

Display

168 x 75 x 176 mm
6.6 x 2.9 x 6.9 inch

Desk or wall mount



1007072090

Handset + Display

225 x 75 x 176 mm
8.9 x 2.9 x 6.9 inch

Desk or wall mount

IP DUAL DISPLAY MASTER STATION

- A. Master station shall have full access to all features in the server.
- B. Master station shall include the following controls:
 - Dialling buttons 0-9
 - Manual "M" button for speech control and other functions
 - Cancel "C" button
 - Privacy switch
 - Variable volume control.
- C. Shall include up to 9x10 direct access keys with information text for each DAK on a 10 lines display.
- D. The direct access keys and DAK display text shall be easily programmed from the station and changed at any time.
- E. Status information, guidance and menus shall be shown on a large 4 lines graphic display.
- F. Shall have 4 navigation keys for quick access to system menus and directory entries.
- G. Shall include a red "Station-on" LED.
- H. Frequency response of input and output shall be 300 to 7,000 Hz.
- I. Output power shall be 1,5 W to internal loudspeaker.
- J. Station shall be in a dark grey and black plastic housing suitable for desk mounting and have a 2 m (6 foot) cord and plug.
- K. It shall be possible to equip the station with a noise cancelling gooseneck microphone.
- L. The station shall support a two-port 10/100 Mbps Ethernet switch of which one Ethernet port shall be used to connect to a PoE switch over an Ethernet cable (Cat 5 or Cat 6). It shall be configured with fixed or dynamic IP-addresses.
- M. The station shall connect directly to IP networks and have an integrated web server for easy configuration, monitoring and remote automatic software updates.
- N. Frequency response of input and output shall be 200 to 7000 Hz.
- O. The station shall provide wideband audio. The codecs are either standard G.711 or the wideband audio codec G.722.
- P. The station shall use an advanced signal processing algorithm to identify and filter out background repetitive noise signal audio.
- Q. The unit shall tag priorities (DiffServ, ToS) at the Ethernet packets, and shall have acoustic echo cancellation and adaptive jitter buffer.
- R. The station shall be supervised from the IP network, and shall be configured from a central server or by using the integrated web-server.

The following STENTOFON Dual Display Stations comply with the above specifications:



1008007000

72 x 140 x 270 mm
2.8 x 5.5 x 10.6 inch

Desktop mount

DUAL DISPLAY MASTER STATION

- A. Master station shall have full access to all features in the server.
- B. Master station shall include the following controls:
 - Dialling buttons 0-9
 - Manual "M" button for speech control and other functions
 - Cancel "C" button
 - Privacy switch
 - Variable volume control.
- C. Shall include up to 4x10 direct access keys with information text for each DAK on a 10 lines display.
- D. The direct access keys and DAK display text shall be easily programmed from the station and changed at any time.
- E. Status information, guidance and menus shall be shown on a large 4 lines graphic display.
- F. Shall have 4 navigation keys for quick access to system menus and directory entries.
- G. Shall include a red "Station-on" LED.
- H. Shall include a 2", 1.6 watt speaker mounted in an acoustic baffle.
- I. Shall include an electret microphone with 100/300 mV output and sensitivity -65dB @1KHz.
- J. Shall include a preamplifier with 1000 ohm output impedance and greater than 40 dB signal to noise ratio.
- K. Frequency response of input and output shall be 300 to 7,000 Hz.
- L. Output power shall be 1 W to internal loudspeaker.
- M. Station shall be in a dark grey and black plastic housing suitable for desk mounting and have a 2 m (6 foot) cord and plug.
- N. It shall be possible to equip the station with a noise cancelling gooseneck microphone.

The following STENTOFON Dual Display Stations comply with the above specifications:



1007007000

72 x 140 x 270 mm
2.8 x 5.5 x 10.6 inch

Desktop mount



1007007010

**With gooseneck
microphone**

72 x 140 x 270 mm
2.8 x 5.5 x 10.6 inch

Desktop mount

IP WALL MOUNT STATION

- A. Master station shall have access to all features in the server.
- B. Master stations shall include the following controls:
 - Dialling buttons 0-9
 - Manual "M" button for speech control and other functions
 - Cancel "C" button
 - Variable volume control.
- C. Station shall include 4 direct access keys (DAK).
- D. Wall mount stations shall be in anodized aluminum, suitable for wall mounting in flush or surface mount back box.
- E. Station shall include a large high contrast display with adjustable backlight which allows important information about connections to be shown.
- F. Station may be equipped with a noise cancelling gooseneck microphone.
- G. The station may be equipped with a handset and/or headset through a RJ11 connector for confidential conversations.
- H. Shall include a red "Station-on" LED.
- I. Shall be 1.5 Watt audio output and 75 dB audio pressure 1 m from speaker
- J. The station shall support a two-port 10/100 Mbps Ethernet switch of which one Ethernet port shall be used to connect to a PoE switch over an Ethernet cable (Cat 5 or Cat 6). It shall be configured with fixed or dynamic IP-addresses.
- K. The station shall connect directly to IP networks and have an integrated web server for easy configuration, monitoring and remote automatic software updates.
- L. Frequency response of input and output shall be 200 to 7000 Hz.
- M. The station shall provide wideband audio. The codecs are either standard G.711 or the wideband audio codec G.722.
- N. The station shall use an advanced signal processing algorithm to identify and filter out background repetitive noise signal audio.
- O. The unit can tag priorities (DiffServ, ToS) at the Ethernet packets, and it has acoustic echo cancellation and adaptive jitter buffer.
- P. The station can be supervised from the IP network, and it can be configured from a central server or by using the integrated web-server.

The following STENTOFON Wall Mount Stations comply with the above specifications:



100803100

Master Standard

125 x 280 x 33 mm

Flush back box: **1008098700**

1008097100	Handset for IP Masters
1008097500	Gooseneck Microphone Kit
1009648001	License: Use as CRMV
1008098800	Backbox for handset

ANALOG WALL MOUNT STATIONS

- A. Master station shall have access to all features in the server.
- B. Master stations shall include the following controls:
 - Dialing buttons 0-9
 - Manual "M" button for speech control and other functions
 - Cancel "C" button
 - Privacy switch
 - Variable volume control.
- C. Shall include a red "Station-on" LED.
- D. Shall include a 3", 1.6 watt speaker with 88 dB sensitivity mounted in an acoustic baffle.
- E. Shall include an electret microphone with 100/300 mV output and sensitivity -65dB @1 KHz.
- F. Shall include a preamplifier with 1000 ohm output impedance and greater than 40 dB signal to noise ratio.
- G. Frequency response of input and output shall be 300 to 5,000 Hz.
- H. Output power shall be 1 W.
- I. Wall mount stations shall be in anodized aluminum, suitable for wall mounting in flush or surface mount back box.
- J. Station may include 8 direct access keys (DAK).
- K. Station may include a two lines, 16 character information LCD display.
- L. Station may be equipped with a noise cancelling gooseneck microphone.

The following STENTOFON Wall Mount Stations comply with the above specifications:



1007040000

Master Standard

125 x 280 x 53 mm

4.9 x 10.9 x 2.1 inch

Flush back box: **6020 000**

Surface back box: **6030 000**



1007042000

Master Display

125 x 280 x 53 mm

4.9 x 10.9 x 2.1 inch

8 DAK Keys

Flush back box: **6020 000**

Surface back box: **6030 000**

INDUSTRIAL MASTER STATIONS

LIGHT INDUSTRIAL MASTER STATION

- A. Shall have access to all features in the server.
- B. The light industrial master station shall be splash proof and designed for humid, dirty and outdoor conditions.
- C. The exterior casing shall be comprised of a flame and chip resistant Bayblend plastic with a UV cured, chemical resistant PVC front panel.
- D. The stations shall include a keyboard foil with:
 - dialling buttons 0-9
 - manual "M" button for speech control and other functions
 - cancel "C" button.
- E. There shall be preset volume control and "always privacy" switch inside the station.
- F. The station shall have a red LED indicator for incoming calls and station in use indication.
- G. The station shall have an IP54 classification.
- H. Temperature and humidity range must be: 0° - +50°C / +32° - +122°F and 10% - 85% RH.
- I. Shall include a 3", 1.6 W loudspeaker
- J. Shall include an electret microphone with 100/300 mV output and sensitivity -65dB @1 KHz.
- K. Shall include a preamplifier with 1000 ohm output impedance and greater than 40 dB signal to noise ratio.
- L. Output power shall be 1 W to internal loudspeaker, sound pressure at 1 m from internal speaker should be 66 db.
- M. Output power to external 20-70 Ohm loudspeaker shall be 1.5 W.
- N. Output power from built-in VOX operated power amplifier shall be 10 W in 8-20 Ohm (separate 12 VAC/2 A power supply required).
- O. Frequency response of input and output shall be 500-5,000 Hz.
- P. Shall have connections for optional handset with microphone impedance 200-600 Ohm.

The following STENTOFON Light Industrial Maser Station complies with the above specifications:



1007080000

124 x 244 x 63 mm

4.9 x 9.5 x 2.5 inch

NOISE CANCELLING INDUSTRIAL MASTER STATION

- A. Shall have access to all features in the server.
- B. This industrial master station shall be weather resistant and designed for humid, dirty and outdoor conditions.
- C. The exterior casing shall be comprised of a chip-resistant orange Macrolon with foil keyboard.
- D. The stations shall include a keyboard foil with:
 - dialing buttons 0-9
 - manual "M" button for speech control and other functions
 - cancel "C" button.
- E. There shall be preset volume control and "always privacy" switch inside the station.
- F. The station shall have a red LED indicator for incoming calls and station in use indication.
- G. The station shall have an IP64 classification.
- H. Temperature and humidity range must be: -20° - +50°C / -4° - +122°F and 10% - 85% RH.
- I. Shall include a noise cancelling microphone.
- J. Shall include a preamplifier with 1000 ohm output impedance and greater than 40 dB signal to noise ratio.
- K. Output power to external 20-70 Ohm loudspeaker shall be 1.5 W.
- L. Output power from built-in VOX operated power amplifier shall be 10 W in 8-20 Ohm (separate 12 VAC/2 A power supply required).
- M. Frequency response of input and output shall be 500-5,000 Hz.
- N. Shall have connections for optional handset with microphone impedance 200-600 Ohm.
- O. Shall include 2 x PG9 glands.

The following STENTOFON Light Industrial Master Station complies with the above specifications

:



1007082000

160 x 240 x 137 mm

6.2 x 9.4 x 5.3 inch

HEAVY DUTY INDUSTRIAL MASTER STATION

- A. Shall have access to all features in the server.
- B. This industrial master station shall be water- and dust-proof and designed for humid, dirty and outdoor conditions.
- C. The exterior casing shall be comprised of orange silumin with brushed aluminium front.
- D. The stations shall include a keyboard with large rubber buttons for:
 - dialing buttons 0-9
 - manual "M" button for speech control and other functions
 - cancel "C" button
 - 4 direct access keys (DAK).
- E. There shall be preset volume control and "always privacy" switch inside the station.
- F. The station shall have a large red indicator light for incoming calls and station in use indication.
- G. The station shall have an IP65 classification.
- H. Temperature and humidity range must be: -20° - +50°C / -4° - +122°F and 10% - 85% RH.
- I. Shall include an electret microphone with 100/300 mV output and sensitivity -65dB @1 KHz.
- J. Shall include a preamplifier with 1000 ohm output impedance and greater than 40 dB signal to noise ratio.
- K. Output power to external 20-70 Ohm loudspeaker shall be 1.5 W.
- L. Output power from built-in VOX operated power amplifier shall be 10 W in 8-20 Ohm (separate 12 VAC/2 A power supply required).
- M. Frequency response of input and output shall be 500-5,000 Hz.
- N. Shall have connections for optional handset with microphone impedance 200-600 Ohm.
- O. Shall include 2 x PG7 and 2 x PG9 glands.

The following STENTOFON Heavy Duty Industrial Master Station complies with the above specifications:



1007086000

160 x 260 x 100 mm

6.2 x 10.2 x 3.9 inch

INDUSTRIAL SUBSTATIONS

HEAVY DUTY INDUSTRIAL SUBSTATIONS, ONE OR THREE BUTTONS

- A. This industrial substation shall be weather resistant and designed for humid, dirty and outdoor conditions.
- B. The exterior casing shall be comprised of a chip-resistant orange silumin.
- C. The stations shall include:
 - one large programmable call button
- D. In addition, the station may include an “M” button for speech control and other functions and a cancel “C” button.
- E. There shall be preset volume control and “always privacy” switch inside the station.
- F. The station shall have a red LED indicator for incoming calls and station in use indication.
- G. The station shall have an IP65 classification.
- H. Temperature and humidity range must be: -20° - +50°C / -4° - +122°F and 10% - 85% RH.
- I. Shall include a noise cancelling microphone.
- J. Shall include a preamplifier with 1000 ohm output impedance and greater than 40 dB signal to noise ratio.
- K. Shall include a 1.5 W built-in loudspeaker.
- L. Output power to external 20-70 Ohm speaker shall be 1.5 W.
- M. Output power from built-in VOX operated power amplifier shall be 10 W in 8-20 Ohm (separate 12 VAC/2 A power supply required).
- N. Frequency response of input and output shall be 500-5,000 Hz.
- O. Shall have connections for optional handset with microphone impedance 200-600 Ohm.
- P. Shall include 3 x PG9 glands

The following STENTOFON Industrial Sub Stations comply with the above specifications:



1007083000

160 x 260 x 92 mm

6.2 x 10.2 x 3.6 inch



1007085000

125 x 280 x 53 mm

4.9 x 10.9 x 2.1 inch

IP Heavy Duty Master Station

- A. Master station shall have access to all features in the server.
- B. Master stations shall include the following controls:
 - Dialling buttons 0-9
 - Manual “M” button for speech control and other functions
 - Cancel “C” button
 - Variable volume control.
- C. Station shall include 4 direct access keys (DAK).
- D. The station housing shall be very durable and consists out 5 mm aluminum casing and stainless steel components
- E. The station shall be equipped with a heavy duty handset and a magnetic reed hook-switch
- F. The stations shall offer 1.5 Watt audio output for an external loud speaker
- G. The station shall have an IP67 classification.
- H. The station shall support a two-port 10/100 Mbps Ethernet switch of which one Ethernet port shall be used to connect to a PoE switch over an Ethernet cable (Cat 5 or Cat 6). It shall be configured with fixed or dynamic IP-addresses.
- I. The station shall support PoE and local power
- J. The station shall connect directly to IP networks and have an integrated web server for easy configuration, monitoring and remote automatic software updates.
- K. Frequency response of input and output shall be 200 to 7000 Hz.
- L. The station shall provide wideband audio. The codecs are either standard G.711 or the wideband audio codec G.722.
- M. The station shall use an advanced signal processing algorithm to identify and filter out background repetitive noise signal audio.
- N. The unit can tag priorities (DiffServ, ToS) at the Ethernet packets, and it has acoustic echo cancellation and adaptive jitter buffer.
- O. The station can be supervised from the IP network, and it can be configured from a central server or by using the integrated web-server.
- P. The station shall have one relay and one logical output. The operation of the outputs shall be programmable.

The following STENTOFON IP Heavy Duty Telephones comply with the above specifications:



1008072100
Heavy Duty IP Telephone
Full keyboard
205 x 320 x 120 mm



1008072200
Heavy Duty IP Telephone
Full keyboard, Door
205 x 320 x 148 mm

IP Heavy Duty Hot Line Station

- A. The Hot Line Station shall have access to all features in the server.
- B. The station housing shall be very durable and consists out 5 mm aluminum casing and stainless steel components
- C. The station shall be equipped with a heavy duty handset and a magnetic reed hook-switch
- D. The station shall be programmed as such that lifting up the handset automatically initiates the call
- E. The stations shall offer 1.5 Watt audio output for an external loud speaker
- F. The station shall have an IP67 classification.
- G. The station shall support a two-port 10/100 Mbps Ethernet switch of which one Ethernet port shall be used to connect to a PoE switch over an Ethernet cable (Cat 5 or Cat 6). It shall be configured with fixed or dynamic IP-addresses.
- H. The station shall support PoE and local power
- I. The station shall connect directly to IP networks and have an integrated web server for easy configuration, monitoring and remote automatic software updates.
- J. Frequency response of input and output shall be 200 to 7000 Hz.
- K. The station shall provide wideband audio. The codecs are either standard G.711 or the wideband audio codec G.722.
- L. The station shall use an advanced signal processing algorithm to identify and filter out background repetitive noise signal audio.
- M. The unit can tag priorities (DiffServ, ToS) at the Ethernet packets, and it has acoustic echo cancellation and adaptive jitter buffer.
- N. The station can be supervised from the IP network, and it can be configured from a central server or by using the integrated web-server.
- O. The station shall have one relay and one logical output. The operation of the outputs shall be programmable.

The following STENTOFON IP Heavy Duty Telephones comply with the above specifications:



1008072120
Heavy Duty IP Telephone
Hotline
205 x 320 x 120 mm



100807210
Heavy Duty IP Telephone
Hotline, Door
205 x 320 x 148 mm

IP CONTROL ROOM MASTER STATION - CRMV

- A. The Control Room Master station shall be a compact desktop console with 1-4 modules.
 - IP Flush Master Unit 1008031000 (always required)
 - Handset unit 1008097100
 - IP DAK unit 1008010100 (1 or 2)

IP FLUSH MASTER UNIT

- A. Master station shall have access to all features in the server.
- B. Master stations shall include the following controls:
 - Dialing buttons 0-9
 - Manual "M" button for speech control and other functions
 - Cancel "C" button
 - Variable volume control.
- C. Station may include 4 direct access keys (DAK).
- D. Wall mount stations shall be in anodized aluminum, suitable for wall mounting in flush or surface mount back box.
- E. Station shall include a large high contrast display with adjustable backlight which allows important information about connections to be shown.
- F. Station may be equipped with a noise cancelling gooseneck microphone.
- G. The station may be equipped with a handset and/or headset through a RJ11 connector for confidential conversations.
- H. Shall include a red "Station-on" LED.
- I. Shall be 1.5 Watt audio output and 75 dB audio pressure 1 m from speaker
- J. The station shall support a two-port 10/100 Mbps Ethernet switch of which one Ethernet port shall be used to connect to a PoE switch over an Ethernet cable (Cat 5 or Cat 6). It shall be configured with fixed or dynamic IP-addresses.
- K. The station shall connect directly to IP networks and have an integrated web server for easy configuration, monitoring and remote automatic software updates.
- L. Frequency response of input and output shall be 200 to 7000 Hz.
- M. The station shall provide wideband audio. The codecs are either standard G.711 or the wideband audio codec G.722.
- N. The station shall use an advanced signal processing algorithm to identify and filter out background repetitive noise signal audio.
- O. The unit can tag priorities (DiffServ, ToS) at the Ethernet packets, and it has acoustic echo cancellation and adaptive jitter buffer.
- P. The station can be supervised from the IP network, and it can be configured from a central server or by using the integrated web-server.

HANDSET UNIT

- A. Shall be lightweight handset with coiled cord and magnetic hook-switch for confidential conversations.
- B. The handset should be mounted on an anodized aluminium plate suitable for flush mounting or desktop mount in back box.

IP DAK 48 UNIT

- A. Shall be a module with 48 programmable direct access keys, each key containing two programmable LEDs.
- B. One or two IP DAK units can be mounted in one console and power shall be provided by the IP Flush Master host.
- C. The IP DAK UNIT shall be connected to the IP FLUSH MASTER UNITE using a RJ45 terminated cable
- D. All software for the IP DAK UNIT shall be located in the IP Flush Master Station
- E. Front plate shall be anodized aluminum for flush mounting or desktop mount in back box.
- F. It shall be possible to add customized labels for the keys on the IP DAK UNIT

The following STENTOFON Control Room Master Station complies with the above specifications:



100803100
IP Flush Master
125 x 280 x 33 mm
Flush back box:
1008098700



1008010100
IP DAK 48 UNIT
125 x 280 x 30 mm
Flush back box:
1008098700



1008097100
Handset for IP Flush Master
67 x 280 x 41 mm



1008097500
Gooseneck Microphone Kit
Length 300 mm

WEATHER AND VANDAL RESISTANT IP SUBSTATIONS

- A. Weather and Vandal Resistant IP substations shall be designed to deliver CCoIP® - Critical Communication over IP.
- B. The stations shall have a 2 mm stainless steel faceplate which can be fastened to a back box with four tamper proof screws.
- C. The loudspeaker and microphone are protected by a tamper and vandal proof grid.
- D. The station shall provide wideband audio. The codecs are either standard G.711 or the wideband audio codec G.722.
- E. The station shall support a two-port 10/100 Mbps Ethernet switch of which one Ethernet port shall be used to connect to a PoE switch over an Ethernet cable (Cat 5 or Cat 6). It shall be configured with fixed or dynamic IP-addresses.
- F. The station can be supervised from the IP network, and it can be configured from a central server or by using the integrated web-server.
- G. The unit can tag priorities (DiffServ, ToS) at the Ethernet packets, and it has acoustic echo cancellation and adaptive jitter buffer.
- H. The unit has one relay output.
- I. *Note to specifier: The station is available in two versions*
 - a. The Substation shall have one mushroom button, for mounting in flush mount 3-gang back box.
 - b. The Substation shall have one or two tamper proof stainless steel button(s), for mounting in flush mount back box on-wall mount back box.

The following STENTOFON Weather and Vandal Resistant IP Substations comply with the above specifications:



1008041100
92 x 180 x 46 mm
3.6 x 7.0 x 2.1 inch



1008051000
114 x 160 x 63 mm
4.4 x 6.2 x 2.4 inch

WEATHER AND VANDAL RESISTANT ANALOG SUBSTATION

- A. Shall be used where vandalism harsh weather conditions are a threat to the equipment.
- B. The stations shall have a 2 mm stainless steel faceplate which can be fastened to a back box with four tamper proof screws.
- C. Shall have one or two large call-in buttons, pre-programmed for call request to master station or program distribution source.
- D. Shall have internal preset volume control.
- E. Shall include a red "Station-on" LED.
- F. Shall include an electret microphone with 100/300 mV output and sensitivity -65dB @1 KHz.
- G. Shall include a preamplifier with 1000 ohm output impedance and greater than 40 dB signal to noise ratio.
- H. Frequency response of input and output shall be 200 to 10,000 Hz.
- I. Output power shall be 1.0W.
- J. Loudspeaker and microphone grille shall be protected with no-penetration barrier.
- K. Temperature and humidity range shall be: 0° to +50°C

The following STENTOFON Weather and Vandal Resistant Analog Substation complies with the above specifications:



1007056100

92 x 180 x 46 mm

3.6 x 7.0 x 2.1 inch

STENTOFON SOFTCLIENT

- A. The Softclient station shall have access to all features in the server.
- B. The Softclient station shall include the following controls:
 - Dialing buttons 0-9
 - Manual "M" button for speech control and other functions
 - Cancel "C" button
 - Private/Open Switch
 - Microphone Mute Button
 - Address Book Button
 - Show/Hide Numpad Button
- C. The Softclient will run on Microsoft Windows® XP/VISTA/Win7 (32bit/64bit)
- D. The Softclient shall be a freely downloadable application
- E. The Softclient shall include status button to indicate Softclient status (green=available – red=inconversation)
- F. The Softclient shall connect to the AlphaCom XE server via the (W)LAN on which the computer is registered either directly or through a VPN Tunnel
- G. The Softclient shall register with the AlphaCom XE server either through a preconfigured extension number or by the MAC-address of the PC it is running on.
- H. The Softclient can only register with the AlphaCom XE server if a there is an available softclient license registered in the server.
- I. The maximum number of registered Softclients in an AlphaCom XE system shall depend on the number of Softclient licenses available in that system.
- J. Frequency response of input and output shall be 200 to 7000 Hz.
- K. The Softclient shall provide wideband audio. The codecs are either standard G.711 or the wideband audio codec G.722.
- L. The Softclient shall tag priorities (DiffServ, ToS) at the Ethernet packets, and shall have acoustic echo cancellation and adaptive jitter buffer.
- M. The Softclient can be operated through Windows® based touch screens

The following STENTOFON Softclient complies with the above specifications:



1009648011	STENTOFON SoftClient - 1 license
1009648012	STENTOFON SoftClient - 6 licenses
1009648013	STENTOFON SoftClient - 12 licenses
1009648014	STENTOFON SoftClient - 36 licenses
1009648015	STENTOFON SoftClient - 138 licenses

IP ARIO UNIT

- A. The unit shall provide an audio signalling interface between PA amplifiers and the audio server.
- B. The unit shall offer two parallel PA audio outputs, enabling the connection of two PA amplifiers
- C. The unit shall provide speaker loop monitoring inputs for each amplifier, as well as additional inputs for the monitoring of PA amplifiers and/or other system components
- D. The unit shall provide an audio signalling interface between radio systems and the audio server.
- E. The unit shall offer a headset connection for listening in on conversations.
- F. The unit shall feature audio in/out, 12V radio “on” signalling as well as a remote server RS232 port for signalling.
- G. The station shall support a two-port 10/100 Mbps Ethernet switch of which one Ethernet port shall be used to connect to a PoE switch over an Ethernet cable (Cat 5 or Cat 6). It shall be configured with fixed or dynamic IP-addresses.
- H. The unit shall support Power over Ethernet (PoE) and a 24Vdc backup power.
- I. The unit shall offer a secondary Ethernet port for redundant cabling.
- J. The unit shall support Rapid Spanning Tree Protocol (RSTP).
- K. The station shall connect directly to IP networks and have an integrated web server for easy configuration, monitoring and remote automatic software updates.
- L. Frequency response of input and output shall be 200 to 7000 Hz.
- M. The station shall provide wideband audio codec G.722.
- N. The unit shall tag priorities (DiffServ, ToS) at the Ethernet packets, and shall have acoustic echo cancellation and adaptive jitter buffer.
- O. The station shall be supervised from the IP network, and shall be configured from a central server or by using the integrated web-server.
- P. The Unit shall be monitored by the audio server and report faults to the server.
- Q. The unit shall monitor the audio connection between itself and the amplifiers.
- R. The unit shall offer 5 LED status indicators for power, connection, fault, activity, Tx/Rx for radio.
- S. The unit shall offer 8 digital inputs
- T. The unit shall offer 8 digital outputs (relays)
- U. The unit shall fit in a 19” rack and be 1U high



1008095100

210 x 44 x 240 mm

8.3 x 1.7 x 9.4 inch

IP DECT BASE SERVER

- A. The IP DECT BASE SERVER shall provide an interface between IP DECT wireless phones and the AlphaCom XE system
- B. It shall integrate by using the SIP protocol allowing calls to and from intercom stations.
- C. The BASE SERVER Limited handle 1 base station and up to 3 repeaters.
- D. The BASE SERVER shall handle 256 base stations to offer an extended wide area on site coverage so calls are not lost. **Note: Only possible with the IP DECT SERVER 6000**
- E. It shall be possible to add DECT repeaters to the system to extend the coverage area
- F. The BASE SERVER shall support handover and support between base stations
- G. It shall provide encrypted radio communication as well as centralized radio planning, configuration and monitoring.



2211010100
IP DECT Server
6000



2211010100
IP DECT
Base 300

IP DECT STATIONS

OFFICE UNIT

- A. Shall have a battery capacity of 20/200 hours (speech/standby)
- B. Shall have a TFT color display, (65 000 colors, 8 lines of text/icons)
- C. Shall have a telephone book with room for 250 entries
- D. Shall have headset options for hands-free usage and noise reduction
- E. Shall have following features:
 - a. Vibrate and silent mode
 - b. Auto answer
 - c. Loud speaking
 - d. LED indication of incoming and unanswered calls
 - e. Volume control
 - f. Call history
 - g. Calling number presentation (CLIP)
- F. Shall be added to the Intercom System by means of a DECT server and a SIP user license

ROUGH UNIT

- A. Shall have a battery capacity of 15/150 hours (speech/standby)
- B. Shall have a large alphanumeric, back-light display
- C. Shall have a telephone book with room for 200 entries
- D. Shall have headset options for hands-free usage and noise reduction
- E. Shall have following features:
 - a. Vibrate and silent mode
 - b. Auto answer
 - c. Loud speaking
 - d. LED indication of incoming and unanswered calls
 - e. Volume control
 - f. Call history
 - g. Calling number presentation (CLIP)
- F. Shall be added to the Intercom System by means of a DECT server and a SIP user license
- G. Shall be IP54

EX UNIT

- A. Shall have a battery capacity of 15/150 hours (speech/standby)
- B. Shall have a large alphanumeric, back-light display
- C. Shall have a telephone book with room for 200 entries
- D. Shall have headset options for hands-free usage and noise reduction
- E. Shall have following features:
 - h. Vibrate and silent mode
 - i. Auto answer
 - j. Loud speaking
 - k. LED indication of incoming and unanswered calls
 - l. Volume control
 - m. Call history
 - n. Calling number presentation (CLIP)
- F. Shall be IP64
- G. Shall be ATEX approved II2G II30 T60oC EEx ib IIC T3
- H. Shall be IEC approved Ex ib IIC T3
- I. Shall be added to the Intercom System by means of a DECT server and a SIP user license

		
2211100120 IP DECT Phone Office	2211100100 IP DECT Phone Rough	2211100110 IP DECT Phone EX

ALPHACOM SOFTWARE LICENSES

- A. ALPHACOM ALPHANET & MULTI-MODULE VOIP LICENSE. This software license makes it possible to establish audio communication between AlphaCom XE servers that are connected in an IP configuration. Each AlphaCom XE server will require a software license. Software license shall be part number #10096400xx where xx is determined depending on the design scope of the system on a node by node basis.

(Note to specifier: Indicate if 10096400xx license(s) are required)

- B. ALPHACOM IP STATION LICENSE. This software license makes it possible to connect and register IP stations (masters & substations) via IP to an AlphaCom XE server. Once IP station is registered it can then place intercom calls just like traditional copper wired stations. Depending on the number of IP station(s) that are required for the job then multiples of IP station license #1009641006 will be required. Software license shall be part number #1009641006 which is good for registering 6 IP stations.

(Note to specifier: Indicate if 1009641006 license(s) are required)

- C. ALPHACOM SIP TRUNKING LICENSE. This software license makes it possible to connect AlphaCom XE to VOIP IP Phone systems or traditional PBX that aren't IP capable if combined and used with a MP-114 or MP-118 SIP Gateway. SIP trunking gives a seamless integration between the AlphaCom XE and other telecom systems supporting SIP which allows for advanced functions. Software license shall be part number #10096420xx where xxx is determined depending on the design scope of the system.

(Note to specifier: Indicate if 10096420xx license(s) are required)

- D. ALPHACOM SIP STATION LICENSE. This software license makes it possible to connect and register SIP based phones via IP with the AlphaCom XE system. Once the SIP based phone is registered it can then place and receive intercom calls must like a traditional intercom station. Depending on the number of SIP phones that are required for the job then multiples of the #1009643006 will be required. Software license shall be #1009643006 which will allow 6 SIP phones to register.

(Note to specifier: Indicate if 1009641006 license(s) are required)

- E. ALPHACOM OPC LICENSE. This software license makes it possible to connect and register details regarding events occurring in the AlphaCom XE intercom system to external OPC based management system. Using this software license greatly reduces the need to write specific interface protocol as OPC is an industry standard based on OPC and Microsoft .Net. Software license shall be #100964990X where x is determined by how many stations you wish to monitor.

(Note to specifier: Indicate if 1009641006 license(s) are required)

- F. AUDIO MESSAGING LICENSES-BASIC AND ENHANCED. This software license makes it possible to store and play audio messages from the AlphaCom XE server. The messages are stored in flash memory on the AMC-IP board. The licenses are compatible with the feature set of the ASVP card but offer some important functionality possibilities such as allowing the modification of default messages as well as adding new messages. New and modified messages can be entered via any intercom station. In addition, it is possible to make messages on a PC and upload to the server via AlphaWeb. Using this license will allow for pre-recorded messages to be played during emergency or scheduled times based on the application of the system. Software license shall be #1009648500 Basic Audio Messaging License or #1009648501 Enhanced Audio Messaging License.

(Note to specifier: Indicate if 1009641006 license(s) are required)

OPTIONS

60 W AMPLIFIER

- A. The amplifier shall be used for distribution of audio for information calls, background music and evacuation messages.
- B. Audio input shall be an intercom server subscriber line and/or other audio sources.
- C. The intercom wire input shall have priority over the AUX input.
- D. The output shall be 60 W on a 100 V line.
- E. There shall be line monitoring on the loudspeaker output.
- F. Status indicators in the front shall show error type: line error, amplifier error, load error, overheating, GND fault and overload.
- G. Volume and bass/treble control shall be accessible in front.
- H. Shall have volume override facility.
- I. Shall go in standby mode to preserve power when no signals are present.
- J. Shall include set and reset keys for programming and service of the amplifier.
- K. Impedance level for line monitoring, time between tests and error detection limits shall be programmable.
- L. Shall include monitoring of amplifier and output for automatic change-over to standby amplifier.
- M. Shall be in closed housing complying with IP20 classification (finger-proof).
- N. Shall meet IEC65/EN60950 requirements.
- O. Up to 6 units shall be mounted in a 3U / 19" rack.

*The STENTOFON InterGuard IG60 Amplifier type **1009971000** complies with the above specifications.*



100997100

70 x 3U x 220 mm

2.7 x 3U x 8.6 inch

GENERAL PURPOSE AUDIO INTERFACE (AGA)

- A. Shall be used for feeding 16 audio program channels into and/or out of the intercom server under software control. One or two boards in one server.
- B. Shall be fed from any analogue audio program source.
- C. Shall be used to provide 8 channels for two-way speech communication between modules in a multi-module system. One, two or three boards in each module.
- D. Shall have galvanic isolated inputs/outputs via 600 Ohm 0 dB transformers.
- E. Shall have plug-in terminals on the board.
- F. Shall have individual adjustable sensitivity (100 mV - 1 V) controllers for all channels.
- G. Shall have a frequency range of 40 – 18.500 Hz.
- H. Shall contain a red/green/amber indicator LED.
- I. Shall have coded connector to ensure correct positioning in the module.
- J. Shall be a “Hot plug in / plug out” device.

*The STENTOFON AGA board for AlphaCom type **1009303001** complies with the above specifications.*



1009303001

263 x 230 x 10 mm

10.3 x 9 x 0.4 inch

NOTE: STENTOFON AGA board can not be used in AlphaCom XE1.

POWER DISTRIBUTION BOARD (PDB)

- A. The PDB board shall be used when it is necessary to supply additional equipment with power from the intercom server.
- B. The power board shall provide +5 V, +15 V, +24 V and +32 V.
- C. All power outputs shall be fuse-protected by 1 A.
- D. Board shall be fastened to mounting rail in the intercom server.

*The STENTOFON PDB board for AlphaCom type **1009971000** complies with the above specifications.*



1009971000

130 x 100 mm

5.7 x 3.9 inch

NOTE: PDB is applicable for AlphaCom XE26 only

RELAY BOARD (MRBD)

- A. Shall be used where relay control is needed to activate devices such as alarm bells, door locks and CCTV camera control from an intercom system.
- B. The board shall be equipped with 6 relays with dual change-over contacts.
- C. The relays shall be activated by programmed general output ports in the intercom server, by a RIO unit or other general outputs in the system.
- D. The RCOs shall be triggered on low or high level input, selected by switches.
- E. The relays shall be powered from +24 V on the Power Distribution Board (PDB).
- F. Current consumption shall not exceed 60 mA with all relays active.
- G. The board shall be fastened to mounting rail in the AlphaCom server.

*The STENTOFON MRBD board for AlphaCom type **1009970200** complies with the above specifications.*



1009970200

100 x 100 mm

3.9 x 3.9 inch

NOTE: STENTOFON MRBD board can not be used in AlphaCom XE1.

FILTER BOARD AND SPEECH ADAPTER WITH RELAY (FBSAR)

- A. This board shall include two audio channels to act as a galvanic interface between the intercom server and external PA- or non-selective radio systems.
- B. One channel shall be equipped with relays and opto-couplers for non-selective radio keying and control.
- C. Both channels shall have filter for the 40 kHz data carrier used in display stations that might cause amplifier overheating on common PA systems.
- D. Audio input level shall be 5 mV – 1.5 V.
- E. Audio output level shall be 0 – 7 V.
- F. Input and output impedance shall be 600 Ohm.
- G. Shall be powered from +24 V on the Power Distribution Board if relays are used.
- H. Current consumption shall not exceed 20 mA with both relays active.
- I. Board shall be fastened to mounting rail in the intercom server.

*The STENTOFON FBSAR board for AlphaCom type **1009505000** complies with the above specifications.*



1009505000

100 x 100 mm

3.9 x 3.9 inch

NOTE: STENTOFON FBSAR board can not be used in AlphaCom XE1.

MICROPHONE AMPLIFIER FOR DYNAMIC & ELECTRET MIC (MADER)

- A. This board shall be used for two way communication through external loudspeaker.
- B. It shall be possible to make announcements by use of a dynamic or electret microphone.
- C. It shall be possible to use the microphone's On/Off button to activate pre-programmed loudspeaker zones for announcement.
- D. The RCO input driver and relay must accept both high and low activation input, selected by a switch.
- E. The microphone level must be adjustable.
- F. It must be possible to select bass boost by a switch.
- G. Shall be powered from +24 V on the Power Distribution Board (PDB) if relay is used.
- H. Current consumption shall not exceed 30 mA when the relay is active.
- I. Board shall be fastened to mounting rail in the AlphaCom server.

*The STENTOFON MADER board for AlphaCom type **1009960100** complies with the above specifications.*



1009960100

70 x 100 mm

2.7 x 3.9 inch

NOTE: STENTOFON MADER board can not be used in AlphaCom XE1.

REMOTE IN/OUT CONTROL (RIO)

- A. The RIO unit shall be included where auxiliary devices need to be operated from the intercom system and/or where external alarm conditions need to be displayed as text or voice message given on intercom stations.
- B. Shall operate on point-to-point connections (RS232) or on a multi-drop bus (RS485).
- C. Each RIO unit shall have 8 inputs and 18 outputs.
- D. All inputs and outputs shall be programmable from the intercom programming tool.
- E. The outputs shall be connected to relay boards with 6 relays each.
- F. It shall be possible to connect up to 30 RIOs to one intercom server.
- G. It shall be possible to chain up to 10 units on one RS485 bus.
- H. It shall be possible to mount RIOs up to 1 km from the server when using RS485.
- I. There shall be status LED on the board and built-in error indication.
- J. The RIO units shall be monitored by the intercom server and error messages shall be displayed on the system station in case of device error.

*The STENTOFON RIO board for AlphaCom type **1009970500** complies with the above specifications.*



1009970500

225 x 125 x 50 mm

10.4 x 5.0 x 22.4 inch

NOTE: STENTOFON RIO board can not be used in AlphaCom XE1.

End Of Section 16775

Section 16781
SMATV System

PART 1 GENERAL

1.01 WORK INCLUDED:

Furnish, install, connect and test a complete community antenna television (CATV) system.

1.02 RELATED WORK

- A General Provisions for Electrical Work
- B. Conduit
- C. Cabinets
- D. Equipment Identification
- E. Lightning Protection System

1.03 REFERENCE STANDARDS

- A. Verband Deutscher Elektrotechniker (VDE) (Association of German Electrical Engineers).
 - 1. VDE 0855: Specifications for Antenna Installations
 - Part 1: Specifications for the Erection of Antenna Installations
 - Part 2: Functional suitability for receiving Antenna Installations.
 - 2. VDE 0887: Radio Frequency Cable, Coaxial, $Z = 75 \text{ ohm}$, for Television Antenna Systems.
 - Part 1: General Requirements
 - Part 2: Indoor Cables
 - Part 3: Outdoor Cables

1.03 REFERENCE STANDARDS (Cont'd)

- B. British Standards B.S.

B.S. 5063 : Specification for cabled distribution systems for sound and television signals.

1.04 SUBMITTALS

- A. Listing of all component manufacturers.
- B. A detailed technical specification of all equipment and systems.
- C. Shop drawings for all components and equipment.
- D. A detailed drawing of the system with the description of each piece of equipment proposed.
- E. A detailed drawing of the system showing the input and output levels at every amplifier for the highest and lowest channel, as well as the levels maintained at the extremities of each line.
- F. Certified copies of field-strength measurements of all specified stations as determined at the site shall be submitted to the Supervising Engineer for approval.
- G. Test data sheets showing field intensity levels for the specified channels, model and type of field intensity meter and calibrated antenna, height of antenna above ground and the system calibration curves shall be submitted. These data sheets shall also show equipment calibration certification dates and calibration agency.

1.05 DESCRIPTION OF SYSTEM

- A. The system shall receive signals from the television and radio stations which can be received in Saudi Arabia, via a community antenna, amplify the signals and distribute them via coaxial cables to the locations as indicated on the drawings and as described herein.
- B. All equipment shall be designed and rated for 230 volts, 50 Hz supply and shall be rated for continuous duty at the site conditions.

1.06 STATION SIGNALS

Station signals shall be received, amplified and distributed on non-adjacent channels throughout the antenna system from the television stations and all FM radio and AM radio transmissions.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. All goods and products covered by this specification shall, when available, be procured from a local manufacturer/agent.
- B. Items of same function and performance are acceptable in accordance with the Specifications.

2.02 SYSTEM PERFORMANCE

- A. Any colour or black-and-white television receiver conforming to EIA Standards, when installed at any outlet on the antenna system, shall produce from any required station a picture and sound quality equal to or exceeding the quality obtained with the same receiver connected directly to the properly oriented and tuned channel antenna at the antenna site. The system shall conform to FCC limitations on radiation and shall be effectively shielded against pickup or generation of noise, undesired signals and interference by any components of the system. The delivered signals shall be free from interference, ghosts, noise, reflections, smear, snow and overload distortions. The following shall be demonstrated in acceptance tests.

1.	Minimum TV signal, all channels	65 dBuV
2.	Maximum TV signal, all outlet, all channels	77 dBuV
3.	Maximum difference between adjacent signals at any one outlet	3.0 dBuV
4.	When measured in 4 MHz bandwidth, overall signal-to-noise ratio for each channel of the system shall not be less than	37 dB
5.	Frequency drift of converted channels for any condition or temperature of operation not more than	0.005 %
6.	Maximum variation of outlet signal for 20 dB variation of antenna signal, above minimum signal	2 dB
7.	Minimum isolation from outlet to outlet	24 dB
8.	Maximum hum modulation	5 %

- B. Phasing characteristics of the antenna system shall not cause ghosts, smears, or double images to appear in receivers used with the system.

2.02 SYSTEM PERFORMANCE (Cont'd)

- C. The FM signal strength at outlets shall equal or exceed the strength of the same signal at the antenna, except that strong signals, greater than 1000 microvolts may be attenuated to prevent television interference. The FM equipment shall be compatible with the TV equipment and the two shall not interfere with one another.

2.03 ANTENNA AND MAST

- A. The antenna shall be mounted on a 6 metre high mast mounted on top of the building as shown on the drawings.
- B. The antenna shall be designed, constructed, installed and oriented such that, when used in conjunction with the system amplification, it will provide the specified signal level, band width, spurious-response rejection and freedom from ghosting caused by undesired radiation. In areas where it is necessary to achieve the required signal characteristics, separate antennae shall be provided and oriented for best reception of each channel so affected. Each antenna shall be designed to match 75 ohm coaxial cable or shall be provided with a matching impedance. Antenna shall be mounted on the mast in accordance with the manufacturer's recommendations. Field strengths tests should be done before offering the system.
- C. Signals in the 88 to 108 MHZ broadcast band shall be received by one broad band antenna and amplified by a broad-band head end amplifier. The antenna shall have a uniform response over the 88-108 MHZ band and shall be oriented to receive the maximum number of FM signals at the most uniform strength.
- D. Obstruction marking and lighting of towers shall comply with local authorities requirements for Defense and Aviation.
- E. The CATV system shall be provided with lightning protection in accordance with the applicable code. Steel masts shall not require air terminals or down conductors but shall be properly grounded. All antenna installed on steel masts shall be bonded directly to the steel mast. All interior equipment, raceways, cabinets, and outlet boxes shall be grounded. Guys shall be continuous without insulators, bonded, and grounded.
- F. The system shall not have radiation in excess of the limits specified by the Code.

2.04 AMPLIFIERS

- A. The amplifier input and output shall be properly matched to the antenna and/or 75 ohm cables.
- B. Single channel amplifiers shall have a noise figure not greater than 10 dB for low band VHF, 12 dB for high band VHF and 14 dB for UHF.
- C. Broadband amplifiers shall have a noise figure not greater than 7 dB for low band VHF, 8 dB for high band VHF and 12 dB for UHF.
- D. Frequency response shall be uniform within plus or minus 1/2 dB over the 6 MHz bandwidths of any channel and within plus or minus 2 dB over all channels of Broadband amplifiers.
- E. Broadband amplifiers shall have separate gain controls or Attenuators shall be provided to balance all channels, or both.
- F. Amplifiers shall comply with VDE0855, shall be inherently stable in operation and shall not require frequent readjustment due to temperature or aging.

2.05 HEADEND UNIT

- A. The headed unit shall have automatic gain control built-in or as separate units and shall have separate manual gain controls for low band VHF, high band UHF and satellite signals.
- B. Headend unit shall include receivers, modulators, amplifiers...etc, to receive signals from satellite dishes, antennas, ASIS signals and local video system.

2.06 FREQUENCY CONVERTERS VIA INTERMEDIATE FREQUENCY

The frequency converters shall have the following features:-

- To convert a CCIR TV channel, standard B/G or standard I or an ORIT TV channel standard D/K.
- Conversion from the VHF1, LSC VHF3, USC or UHF bands to any chosen VHF or UHF channel via the standard intermediate frequency.
- Consisting of two single components, an input converter ... and an output converter.

INPUT CONVERTER

The input converter shall have the following features:

- Converts one input channel to the standard IF band.
- Regulates IF output signal set at the works to 100 dBu V, other IF output levels shall be indicated.
- Level control to reduce input signals.
- 1 connecting jumper 75 ohm shall be included.

OUTPUT CONVERTERS

The output converter shall have the following features:

- Converts from the standard IF band to an output channel in the VHF or UHF band.
- Output level set to the works to 120 dBu V at an IF input level of 100 dBuV.
- For feeding additional video programmes into community antenna systems capable of combination with the TV modulators LMO.
- 1 connecting jumper 75 ohm shall be included.

2.07 TRUNK LINE AMPLIFIERS

- A. Trunk line amplifiers shall be provided where necessary.
- B. The amplifiers shall be routed in corrosion resistant, heavy duty, weather proof enclosures with Glanded cable entries.
- C. The amplifiers shall receive their power supply from the nearest socket outlet.

2.08 SPLITTER UNITS

- A. Splitter units shall be provided in locations as necessary for the project.
- B. Splitter units shall consist of a multiway passive network mounted in corrosion resistant, heavy duty, die- cast, weather proof enclosures with Glanded cable entries.
- C. Unused outlets shall be furnished with 75 ohm terminators.

2.09 TAP-OFF UNITS

- A. Tap-off units shall be provided in locations as indicated on the drawings.
- B. Tap-off units shall consist of a passive network and shall supply a group of outlets as indicated.
- C. Tap-off units shall be mounted in corrosion resistant, heavy duty, die cast, weatherproof enclosures with Glanded cable entries.
- D. Unused outlets shall be furnished with 75ohm terminators.

2.10 COAXIAL CABLE

- A. All coaxial cables used for trunk and distribution lines shall be double screened and shall comply with VDE 0887.

2.11 SATELLITE RECEIVING SYSTEM

- A. The system shall consist of, but not be limited to the following typical equipment for the reception of the channels transmitted, from ARABSAT, (Hot bird), NILESAT.
- B. Typical Equipment for SMATV

10ft mesh dish as described below
Channels to be received (to be selected by the Owner) using demodulators and modulators.
- C. SATELLITE DISH

Satellite dish to be digital type.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Equipment shall be installed in accordance with the manufacturers instructions and in accordance with the drawings.
- B. Special care shall be taken with the installation of coaxial cables to avoid damage due to rough handling and short radius bends.

3.02 TESTING AND COMMISSIONING

- A. Acceptance tests shall be performed by the Contractor in the presence of the Supervising Engineer.
- B. The Contractor shall provide all meters, instruments, signal generators, oscilloscope, receivers, and other devices necessary for such tests. The colour receiver used in the tests shall conform to EIA Standards.
- C. The following tests shall be performed in addition to those tests detailed above under the System Performance paragraph.
 - 1. Input Signal: Signal voltages from the antenna shall be measured at the main amplifier input on all required channels. Signals shall be observed on each required channel using any receiver designated by the Contracting Officer. In case of a poor signal, measurements and observations may be required at the antenna terminals on the mast to verify that no improvement of the signal is feasible.
 - 2. Signal at Outlets: Using the field-strength meter, the video level for the highest and lowest frequency channel distributed on the system shall be read at various taps at random. The signal on each channel shall read not less than 1,000 microvolts and not more than 10,000 microvolts. Using the receiver used at the antenna site, the various channels shall be observed at various outlets, to reproduce a signal of equal or better quality than that obtained at the antenna. The Contractor shall demonstrate that the automatic gain control complies with the requirements of paragraph 2.05 above.

3.03 OPERATION AND MAINTENANCE INSTRUCTIONS

- A. Four complete bound manuals of operating and maintenance instructions shall be provided. Two copies shall be written in Arabic and two in English language.
- B. The manuals shall include complete data on every component of the system, circuit diagrams, parts lists, alignment procedures, adjustments, signal levels, test points, and troubleshooting procedures using TV receiver, signal generator, oscilloscope, signal strength meter and high-resistance voltmeter.

- C. During the final adjustments and acceptance tests and for a period of not less than two days, the Contractor shall instruct and demonstrate to designated owners staff, all operation, adjustment and test procedures.

3.04 SPARE PARTS SUPPORT

- A. In his tender, the Contractor shall provide full details of the local service organization of the manufacturer of the system.
- B. An individually priced, itemized list of recommended spare parts suitable for one year normal maintenance shall be provided. Spare parts shall be identified as consumable spares, critical for unit operation, or special tasks.

*****End of Section*****

Guide Specification for BMS

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PART 1 - General

1.1 Related Documents

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 Related Sections

- A. This Section includes the Building Management System (BMS) control equipment for HVAC systems and components, including open protocol control components for terminal heating and cooling units. Depending on the scope of the project, the complete specification may have numerous sections that interface to this section, including several from Division 25.
- B. Additional related sections and sub-sections can apply.

- 1. 25 01 00 Operation and Maintenance of Integrated Automation
- 2. 25 08 00 Commissioning of Integrated Automation
- 3. 25 11 00 Integrated Automation Network Devices
- 4. 25 13 00 Integrated Automation Control and Monitoring Network
- 5. Add additional sections as required.

1.3 Standard Terms

A. Standard

- 1. ASHRAE: American Society Heating, Refrigeration, Air Conditioning Engineers
- 2. AHU: Air Handling Unit
- 3. BACnet: Building Automation Controls Network
- 4. BMS: Building Management System
- 5. DDC: Direct Digital Control
- 6. EIA: Electronic Industries Alliance
- 7. GUI: Graphical User Interface
- 8. HVAC: Heating, Ventilation, and Air Conditioning
- 9. IEEE: Institute Electrical Electronic Engineers
- 10. MER: Mechanical Equipment Room
- 11. PID: Proportional, Integral, Derivative
- 12. VAV: Variable Air Volume Box

B. Communications and protocols

- 1. ARP: Address Resolution Protocol
- 2. CORBA: Common Object Request Broker Architecture
- 3. CSMA/CD: Carrier Sense Multiple Access/Collision Detect
- 4. DDE: Dynamic Data Exchange
- 5. FTT: Free Topology Transceivers
- 6. HTTP: Hyper Text Transfer Protocol
- 7. IIOP: Internet Inter-ORB Protocol

8. LAN: Local Area Network
9. LON: Echelon Communication – Local Operating Network
10. MS/TP: Master Slave Token Passing
11. ODBC: Open DataBase Connectivity
12. ORB: Object Request Broker
13. SNVT: Standard Network Variables Types
14. SQL: Structured Query Language
15. UDP: User Datagram Protocol
16. XML: eXtensible Markup Language

C. Controllers

1. ASD: Application Specific Device
2. AAC: Advanced Application Controller
3. ASC: Application Specific Controller.
4. CAC: Custom Application Controller.
5. NSC: Network Server Controller
6. PPC: Programmable Process Controller
7. SDCU: Standalone Digital Control Units
8. SLC: Supervisory Logic Controller
9. UEC: Unitary Equipment Controller
10. VAVDDC: Variable Air Volume Direct Digital Controller

D. Tools and Software

1. CCDT: Configuration, Commissioning and Diagnostic Tool
2. BPES: BACnet Portable Engineering Station
3. LPES: LON Portable Engineering Station
4. POT: Portable Operator's Terminal

1.4 Qualifications of Bidder and Pre-bid Submittal

- A. All bidders must be building automation contractors in the business of installing direct digital control building automation systems for a minimum of 3 years.
- B. The Building Management System contractor shall have a full service facility within 100 miles of the project that is staffed with engineers trained and certified by the manufacturer in the configuration, programming and service of the automation system. The contractor's technicians shall be fully capable of providing instructions and routine emergency maintenance service on all system components.
 1. Any installing contractor, not listed as prequalified in the Approved Manufacturer's section, shall submit credentials as detailed in the Pre-bid Submittal section for the engineer's review 2 weeks prior to bid date. Failure to follow the attached formats shall disqualify potential alternate bidders. Credentials must attest that the contractor meets all requirements of the specification and the Engineers judgment regarding approval to bid as an acceptable installer after reviewing the data will be final.
- C. All bidders must be authorized distributors or branch offices of the manufacturers specified.
- D. The following bidders have been pre-qualified:
 1. Schneider Electric
 2. Or as approved by Owners.
- E. Any installing contractors or manufacturers interested in participating as acceptable bidders for this project that are not pre-qualified shall furnish a detailed technical pre-bid submittal to the

consulting engineer. All information must be submitted 2 weeks prior to the published bid date to allow the engineer adequate time to review the bidder's credentials.

F. The Pre-Bid submittal shall contain the following information as a minimum:

1. A profile of the manufacturer and the local installation and service/organization.
2. Description of how the system meets and achieves all the specified criteria in terms of configuration, operation, and control.
3. System Architecture with single line riser diagram showing all major components (digital controllers, routers, hubs, etc.) that will be required for this project.
4. Procedure for commissioning and time required to startup and commission each of the systems for this project.
5. Contractors approach for the project planning and management.
6. Product Data Sheets for all components, DDC panels, and all accessories listed per the appropriate specification sections herein.
7. Examples of actual graphic screens for other similar projects.
8. Number and types of DDC panels required for this installation.
9. Number and types of spare points provided with the proposed system.
10. Recommended spare parts list for components with list price schedule.
11. List of 2 similar systems in size, point capacity, total installed value, installed and commissioned by the local office with a list of the installers/manufacturers design team members for each project and the owners contact information.
12. Samples of service offerings and a list of current similar service contracts with contact information.
13. Resumes for the management team and all employees who will be involved with the project design, commissioning, project management, and after installation service. Resumes should include copies of manufacturer's certifications for the proposed product line.
14. Copy of this Control Specification in its entirety with a check mark beside each paragraph to signify that the manufacturer's equipment and software shall fully conform to the specified requirement. If the requirement cannot be met, indicate the reasons/limitations and the alternative proposed.
15. An interview may be conducted and the bidder will be requested to make a formal presentation concerning the proposed system and possibly provide an installed project tour prior to a final decision.

1.5 Scope of Work

A. The Contractor shall furnish and install a complete building automation system including all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for in this specification. All components of the system – workstations, servers, application controllers, unitary controllers, etc. shall communicate using the BACnet protocol, as defined by ASHRAE Standard 135-2007, or EIA standard 709.1, the LonTalk™ protocol, or Modbus protocol. No gateways shall be used for communication to controllers furnished under this section. At a minimum, provide controls for the following:

1. Air handling units
2. Return air fans
3. Exhaust and supply fans
4. Chilled water system including pumps, chillers, and cooling towers
5. Boilers including hot water pumps
6. Computer room air handling units
7. Refrigerant leak detection system

8. Smoke evacuation sequence of AHUs and return fans including smoke control dampers and fire command override panel.
 9. Finned tube radiation control
 10. Variable volume and constant volume box control including interlocks with finned tube radiation.
 11. Cabinet unit heater controls
 12. Monitoring points for packaged equipment such as emergency generators,
 13. Power wiring to DDC devices, smoke control dampers and BAS panels except as otherwise specified.
- B. Except as otherwise noted, the control system shall consist of all necessary Ethernet Network Controllers, Standalone Digital Control Units, workstations, software, sensors, transducers, relays, valves, dampers, damper operators, control panels, and other accessory equipment, along with a complete system of electrical interlocking wiring to fill the intent of the specification and provide for a complete and operable system. Except as otherwise specified, provide operators for equipment such as dampers if the equipment manufacturer does not provide these. Coordinate requirements with the various Contractors.
- C. The BAS contractor shall review and study all HVAC drawings and the entire specification to familiarize themselves with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc. to be provided.
- D. All interlocking wiring, wiring and installation of control devices associated with the equipment listed below shall be provided under this Contract. When the BAS system is fully installed and operational, the BAS Contractor and representatives of the Owner will review and check out the system – see System Acceptance and Testing section of this document. At that time, the BAS contractor shall demonstrate the operation of the system and prove that it complies with the intent of the drawings and specifications.
- E. Provide services and manpower necessary for commissioning of the system in coordination with the HVAC Contractor, Balancing Contractor and Owner's representative.
- F. All work performed under this section of the specifications will comply with all governing codes, laws and governing bodies. If the drawings and/or specifications are in conflict with governing codes, the Contractor, with guidance from the engineer, shall submit a proposal with appropriate modifications to the project to meet code restrictions. If this specification and associated drawings exceed governing code requirements, the specification will govern. The Contractor shall obtain and pay for all necessary construction permits and licenses.

1.6 System Description

- A. In accordance to the scope of work, the system shall also provide a graphical, web-based, operator interface that allows for instant access to any system through a standard browser. The contractor must provide PC-based programming workstations, operator workstations and microcomputer controllers of modular design providing distributed processing capability, and allowing future expansion of both input/output points and processing/control functions.

For this project, the system shall consist of the following components:

1. Administration and Programming Workstation(s): The BAS Contractor shall furnish (qty) Administration and Programming Workstation Computers as described in Part 2 of the specification. These workstations must be running the standard workstation software developed and tested by the manufacturer of the network server controllers and the standalone controllers. No third party front-end workstation software will be acceptable. Workstations must conform to the B-OWS BACnet device profile.

2. Web-Based Operator Workstations: The BAS Contractor shall furnish licenses for (qty) concurrent web browser based users to the BAS system. Web-based users shall have access to all system points and graphics, shall be able to receive and acknowledge alarms, and shall be able to control setpoints and other parameters. All engineering work, such as trends, reports, graphics, etc. that are accomplished from the WorkStation shall be available for viewing through the web browser interface without additional changes. The web-based interface must conform to the B-OWS BACnet device profile. There will be no need for any additional computer based hardware to support the web-based user interface.
 3. Ethernet-based Network Router and/or Network Server Controller(s): The BAS Contractor shall furnish (qty) Ethernet-based Network Server Controllers as described in Part 2 of the specification. These controllers will connect directly to the Operator Workstation over Ethernet at a minimum of 100mbps, and provide communication to the Standalone Digital Control Units and/or other Input/Output Modules. Network Server Controllers shall conform to BACnet device profile B-BC. Network controllers that utilize RS232 serial communications or ARCNET to communicate with the workstations will not be accepted.
Network Controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as Network Server Controllers (B-BC).
 4. Standalone Digital Control Units (SDCUs): Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU will operate completely standalone, containing all of the I/O and programs to control its associated equipment. Each BACnet protocol SDCU shall conform to the BACnet device profile B-AAC.
BACnet SDCUs shall be tested and certified by the BACnet Testing Laboratory (BTL) as Advanced Application Controllers (B-AAC).
- B. The Local Area Network (LAN) shall be either a 10 or 100 Mbps Ethernet network supporting BACnet, Modbus, Java, XML, HTTP, and CORBA IIOP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Server Controllers (NSCs), user workstations and a local host computer system.
- C. The Enterprise Ethernet (IEEE 802.3) LAN shall utilize Carrier Sense Multiple/Access/Collision Detect (CSMA/CD), Address Resolution Protocol (ARP) and User Datagram Protocol (UDP) operating at 10 or 100 Mbps.
- D. The system shall enable an open architecture that utilizes EIA standard 709.1, the LonTalk™ protocol and/or ANSI / ASHRAE™ Standard 135-2007, BACnet functionality to assure interoperability between all system components. Native support for the LonTalk™ protocol and the ANSI / ASHRAE™ Standard 135-2007, BACnet protocol are required to assure that the project is fully supported by the HVAC open protocols to reduce future building maintenance, upgrade, and expansion costs.
- E. The system shall enable an architecture that utilizes a MS/TP selectable 9.6-76.8 KBAud protocol, as the common communication protocol between all controllers and integral ANSI / ASHRAE™ Standard 135-2008, BACnet functionality to assure interoperability between all system components. The AAC shall be capable of communicating as a MS/TP device or as a BACnet IP device communicating at 10/100 Mbps on a TCP/IP trunk. The AAC shall have a MS/TP bus that is capable of supporting up to 127 UEC's or VAVDDC's without the addition of repeaters. The ANSI / ASHRAE™ Standard 135-2008, BACnet protocol is required to assure that the project is fully supported by the leading HVAC open protocol to reduce future building maintenance, upgrade, and expansion costs.

- F. LonTalk™ packets may be encapsulated into TCP/IP messages to take advantage of existing infrastructure or to increase network bandwidth where necessary or desired.
1. Any such encapsulation of the LonTalk™ protocol into IP datagrams shall conform to existing LonMark™ guide functionality lines for such encapsulation and shall be based on industry standard protocols.
 2. The products used in constructing the BMS shall be LonMark™ compliant.
 3. In those instances in which Lon-Mark™ devices are not available, the BMS contractor shall provide device resource files and external interface definitions for LonMark devices.
- G. The software tools required for network management of the LonTalk™ protocol and the ANSI / ASHRAE™ Standard 135-2008, BACnet protocol must be provided with the system. Drawings are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans and are required to meet the functional intent, shall be provided without additional cost to the Owner. Minimum BACnet compliance is Level 4; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet IP or MS/TP. Physical connection of LonWorks devices shall be via Ethernet IP or FTT-10A.
- H. The system shall support Modbus TCP and RTU protocols natively, and not require the use of gateways.
- I. Complete temperature control system to be DDC with electronic sensors and electronic/electric actuation of Mechanical Equipment Room (MER) valves and dampers and electronic actuation of terminal equipment valves and actuators as specified herein. The BMS is intended to seamlessly connect devices throughout the building regardless of subsystem type, i.e. variable frequency drives, low voltage lighting systems, electrical circuit breakers, power metering and card access should easily coexist on the same network channel.
1. The supplied system must incorporate the ability to access all data using Java enabled browsers without requiring proprietary operator interface and configuration programs.
 2. Data shall reside on a supplier-installed server for all database access.
 3. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network.
- J. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the approved manufacturer's local field office. The approved manufacturer's local field office shall have a minimum of 3 years of installation experience with the manufacturer and shall provide documentation in the bid and submittal package verifying longevity of the installing company's relationship with the manufacturer when requested. Supervision, hardware and software engineering, calibration and checkout of the system shall be by the employees of the approved manufacturer's local field office and shall not be subcontracted. The control contractor shall have an in place support facility within 100 miles of the site with factory certified technicians and engineers, spare parts inventory and all necessary test and diagnostic equipment for the installed system, and the control contractor shall have 24 hours/day, 7 days/week emergency service available.
- K. Provide the Commissioning, configuration and diagnostic tool (CCDT), color display personnel computer, software, and interfaces to provide uploading/downloading of High Point Count Controllers (AAC), Unitary Equipment Controllers (UEC) and VAV controllers (VAVDDC) monitoring all BACnet objects, monitoring overrides of all controller physical input/output points, and editing of controller resident time schedules.
- L. Provide a Portable Operator's Terminal (POT) color display personnel computer, software, and interfaces to provide uploading/downloading of Custom Application Controller and Application

Specific Controllers databases, monitoring of all LonMark™ Standard Network Variables Types (SNVTs) including display of all bound SNVTs, monitoring and overrides of all controller physical input/output points, and editing of controller resident time schedules. POT connectivity shall be via digital wall sensor connected to controller.

1.7 Work by Others

- A. The BAS Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others' work.
- B. The BAS Contractor shall furnish all control valves, sensor wells, flow meters and other similar equipment for installation by the Mechanical Contractor.
- C. The BAS Contractor shall provide field supervision to the designated contractor for the installation of the following:
 - 1. Automatic control dampers
 - 2. Fire/smoke dampers
 - 3. Blank-off plates for dampers that are smaller than duct size.
 - 4. Sheet metal baffles plates to eliminate stratification.
 - 5. The Electrical Contractor shall provide:
 - a. All power wiring to motors, heat trace, junction boxes for power to BAS panels.
 - b. Furnish smoke detectors and wire to the building fire alarm system. HVAC Contractor to mount devices. BAS Contractor to hardwire to fan shut down.
 - c. Auxiliary contact (pulse initiator) on the electric meter for central monitoring of kWH and KW. Electrical Contractor shall provide the pulse rate for remote readout to the BAS. BAS contractor to coordinate this with the electrical contractor.
- D. The BAS Contractor shall provide:
 - 1. All power wiring to all smoke damper actuators for smoke control sequence.

1.8 Code Compliance

- A. Provide BAS components and ancillary equipment, which are UL-916 listed and labeled.
- B. All equipment or piping used in conditioned air streams, spaces or return air plenums shall comply with NFPA 90A Flame/Smoke/Fuel contribution rating of 25/50/0 and all applicable building codes or requirements.
- C. All wiring shall conform to the National Electrical Code.
- D. All smoke dampers shall be rated in accordance with UL 555S.
- E. Comply with FCC rules, Part 15 regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments.
- F. Comply with FCC, Part 68 rules for telephone modems and data sets.

1.9 Submittals

- A. All shop drawings shall be prepared in Visio Professional or AutoCAD software. In addition to the drawings, the Contractor shall furnish a CD containing the identical information. Drawings shall be B size or larger.
- B. Shop drawings shall include a riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical

- system showing all connected points with reference to their associated controller. Typical will be allowed where appropriate.
- C. Submittal data shall contain manufacturer's data on all hardware and software products required by the specification. Valve, damper and air flow station schedules shall indicate size, configuration, capacity and location of all equipment.
 - D. Software submittals shall contain narrative descriptions of sequences of operation, program listings, point lists, and a complete description of the graphics, reports, alarms and configuration to be furnished with the workstation software. Information shall be bound or in a three ring binder with an index and tabs. Diagrams shall be on 11" by 17" foldouts. If color has been used to differentiate information, the printed copies shall be in color.
 - E. Submit five (5) copies of submittal data and shop drawings to the Engineer for review prior to ordering or fabrication of the equipment. The Contractor, prior to submitting, shall check all documents for accuracy.
 - F. The Engineer will make corrections, if required, and return to the Contractor. The Contractor will then resubmit with the corrected or additional data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully approved.
 - G. The following is a list of post construction submittals that shall be updated to reflect any changes during construction and re-submitted as "As-Built".
 - 1. System architecture drawing.
 - 2. Layout drawing for each control panel
 - 3. Wiring diagram for individual components
 - 4. System flow diagram for each controlled system
 - 5. Instrumentation list for each controlled system
 - 6. Sequence of control
 - 7. Binding map
 - 8. Operation and Maintenance Manuals
 - H. Information common to the entire system shall be provided. This shall include but not be limited to the following.
 - 1. Product manuals for the key software tasks.
 - 2. Operating the system.
 - 3. Adminstrating the system.
 - 4. Engineering the operator workstation.
 - 5. Application programming.
 - 6. Engineering the network.
 - 7. Setting up the web server.
 - 8. Report creation.
 - 9. Graphics creation.
 - 10. All other engineering tasks.
 - 11. System Architecture Diagram.
 - 12. List of recommended maintenance tasks associated with the system servers, operator workstations, data servers, web servers and web clients.
 - 13. Define the task.
 - 14. Recommend a frequency for the task.
 - 15. Reference the product manual that includes instructions on executing the task.
 - 16. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
 - 17. Licenses, guarantees, and warranty documents for equipment and systems.
 - 18. Submit one copy for each building, plus two extra copies.
 - I. Information common to the systems in a single building shall be provided.

1. System architecture diagram for components within the building annotated with specific location information.
 2. As-built drawing for each control panel.
 3. As-built wiring design diagram for all components.
 4. Installation design details for each I/O device.
 5. As-built system flow diagram for each system.
 6. Sequence of control for each system.
 7. Binding map for the building.
 8. Product data sheet for each component.
 9. Installation data sheet for each component.
 10. Submit two copies for each building and two extra copies.
- J. Software shall be provided:
1. Submit a copy of all software installed on the servers and workstations.
 2. Submit all licensing information for all software installed on the servers and workstations.
 3. Submit a copy of all software used to execute the project even if the software was not installed on the servers and workstations.
 4. Submit all licensing information for all of the software used to execute the project.
 5. All software revisions shall be as installed at the time of the system acceptance.
 6. Firmware Files
 7. Submit a copy of all firmware files that were downloaded to or pre-installed on any devices installed as part of this project.
 8. This does not apply to firmware that is permanently burned on a chip at the factory and can only be replaced by replacing the chip.
 9. Submit a copy of all application files that were created during the execution of the project.
 10. Submit a copy of all graphic page files created during the execution of the project.

1.10 Coordination

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate equipment from other divisions including "Intrusion Detection," "Lighting Controls," "Motor Control Centers," "Panel boards," and "Fire Alarm" to achieve compatibility with equipment that interfaces with those systems.
- C. Coordinate supply of conditioned electrical circuits for control units and operator workstation.
- D. Coordinate location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete".
- E. Coordinate with the Owner's IT department on locations for UNC's, Ethernet communication cabling and TCP/IP addresses.

1.11 Ownership

- A. The Owner shall retain licenses to software for this project.
- B. The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition off this contractor. Such license shall grant use of all programs and application software to the Owner as defined by the manufacturer's license agreement, but shall protect the manufacturer's rights to disclosure of Trade Secrets contained within such software.
- C. The licensing agreement shall not preclude the use of the software by individuals under contract to the owner for commissioning, servicing or altering the system in the future. Use of the software

- by individuals under contract to the owner shall be restricted to use on the owner's computers and only for the purpose of commissioning, servicing, or altering the installed system.
- D. All project developed software, files and documentation shall become the property of the Owner. These include but are not limited to:
1. Server and workstation software
 2. Application programming tools
 3. Configuration tools
 4. Network diagnostic tools
 5. Addressing tools
 6. Application files
 7. Configuration files
 8. Graphic files
 9. Report files
 10. Graphic symbol libraries
 11. All documentation

1.12 Quality Assurance - System Startup and Commissioning

- A. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS will be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the warranty period. A written report will be submitted to the owner indicating that the installed system functions in accordance with the plans and specifications.
- B. The BAS contractor shall commission and set in operating condition all major equipment and systems, such as the chilled water, hot water and all air handling systems, in the presence of the equipment manufacturer's representatives, as applicable, and the Owner and Architect's representatives.
- C. The BAS Contractor shall provide a technician for 4 days manpower and engineering services required to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing all systems in the building. The BAS Contractor shall coordinate all requirements to provide a complete air balance with the Balancing Contractor and shall include all labor and materials in his contract.
- D. Startup Testing shall be performed for each task on the startup test checklist, which shall be initiated by the technician and dated upon test was completion along with any recorded data such as voltages, offsets or tuning parameters. Any deviations from the submitted installation plan shall also be recorded.
- E. Required elements of the startup testing include:
1. Measurement of voltage sources, primary and secondary
 2. Verification of proper controller power wiring.
 3. Verification of component inventory when compared to the submittals.
 4. Verification of labeling on components and wiring.
 5. Verification of connection integrity and quality (loose strands and tight connections).
 6. Verification of bus topology, grounding of shields and installation of termination devices.
 7. Verification of point checkout.
 8. Each I/O device is landed per the submittals and functions per the sequence of control.
 9. Analog sensors are properly scaled and a value is reported
 10. Binary sensors have the correct normal position and the state is correctly reported.

11. Analog outputs have the correct normal position and move full stroke when so commanded.
 12. Binary outputs have the correct normal state and respond appropriately to energize/de-energize commands.
 13. Documentation of analog sensor calibration (measured value, reported value and calculated offset).
 14. Documentation of Loop tuning (sample rate, gain and integral time constant).
- F. A performance verification test shall also be completed for the operator interaction with the system. Test elements shall be written to require the verification of all operator interaction tasks including, but not limited to the following.
1. Graphics navigation.
 2. Trend data collection and presentation.
 3. Alarm handling, acknowledgement and routing.
 4. Time schedule editing.
 5. Application parameter adjustment.
 6. Manual control.
 7. Report execution.
 8. Automatic backups.
 9. Web Client access.
- G. A Startup Testing Report and a Performance Verification Testing Report shall be provided upon test completion.

1.13 Warranty and Maintenance

- A. All components, system software, and parts furnished and installed by the BMS contractor shall be guaranteed against defects in materials and workmanship for 1 year of substantial completion. Labor to repair, reprogram, or replace these components shall be furnished by the BMS contractor at no charge during normal working hours during the warranty period. Materials furnished but not installed by the BMS contractor shall be covered to the extent of the product only. Installation labor shall be the responsibility of the trade contractor performing the installation. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks. The Contractor shall respond to the owner's request for warranty service within 24 standard working hours.

1.14 Training

- A. The BAS Contractor shall provide both on-site and classroom training to the Owner's representative and maintenance personnel per the following description:
- B. On-site training shall consist of a minimum of (40) hours of hands-on instruction geared at the operation and maintenance of the systems. The curriculum shall include
1. System Overview
 2. System Software and Operation
 3. ☐System access
 4. ☐Software features overview
 5. Changing setpoints and other attributes
 6. Scheduling
 7. Editing programmed variables
 8. Displaying color graphics
 9. Running reports

10. Workstation maintenance
11. Viewing application programming
12. Operational sequences including start-up, shutdown, adjusting and balancing.
13. Equipment maintenance.
14. Factory, classroom training will include a minimum of (2) training reservation for a 3 day course with material covering workstation operation tuition free with travel expense responsibility of the owner. The option for 2-3 weeks of system engineering and controller programming shall be possible if necessary and desired.

PART 2 - Products

2.1 Pre-approved Manufacturers

- A. Subject to compliance with requirements, provide products by one of the following pre-qualified manufacturers:
1. Electric Components
 - a. Schneider-Electric Field Devices
 2. Electronic Components
 - a. Schneider-Electric Field Devices
 3. Direct Digital Control Systems Devices:
 - a. Schneider-Electric I/A BACnet or LON series, Continuum BACnet series, TAC Xenta LON series installed by approved manufacturer's local field office.

2.2 System Architecture

A. General

1. The Building Automation System (BAS) shall consist of Network Server/Controllers (NSCs), a family of Standalone Digital Control Units (SDCUs), Administration and Programming Workstations (APWs), and Web-based Operator Workstations (WOWs). The BAS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN) if applicable.
2. An Enterprise Level BAS shall consist of an Enterprise Server, which enables multiple NSCs (including all graphics, alarms, schedules, trends, programming, and configuration) to be accessible from a single Workstation simultaneously for operations and engineering tasks.
3. For Enterprise reporting capability and robust reporting capability outside of the trend chart and listing ability of the Workstation, a Reports Server shall be installed on a Microsoft Windows based computer. The Reports Server can be installed on the same computer as the Enterprise Server.
4. The system shall be designed with a top-level 10/100bT Ethernet network, using the BACnet/IP, LonWorks IP, and/or Modbus TCP protocol. A sub-network of SDCUs using the BACnet MS/TP, LonTalk FTT-10A, and/or Modbus RTU protocol shall connect the local, stand-alone controllers with Ethernet-level Network Server Controllers/IP Routers.

B. TCP/IP Level

1. The TCP/IP layer connects all of the buildings on a single Wide Area Network (WAN) isolated behind the campus firewall. Fixed IP addresses for connections to the campus WAN shall be used for each device that connects to the WAN.

C. Fieldbus Level with Standalone Digital Control Units (SDCUs)

1. The fieldbus layer shall support all of the following types of SDCUs:

- a. BACnet SDCU requirements: The system shall consist of one or more BACnet MS/TP field buses managed by the Network Server Controller. Minimum speed shall be 76.8kbps. The field bus layer consists of an RS485, token passing bus that supports up to 50 Standalone Digital Control Units (SDCUs) for operation of HVAC and lighting equipment. These devices shall conform to BACnet standard 135-2007
- b. LonWorks SDCU requirements: The system shall consist of one or more LonWorks FTT-10A field buses managed by the Network Server Controller. Minimum speed shall be 76.8kbps. The field bus layer shall consist of up to 50 SDCUs using peer-to-peer, event-driven communication for operation of HVAC and lighting equipment.
- c. Modbus SDCU requirements: The system shall consist of one or more Modbus RTU (RS-485 or RS-232) field buses managed by the Network Server Controller. The field bus layer shall consist of up to 240 SDCUs for operation of HVAC, power metering, and lighting equipment.

D. BAS LAN Segmentation

1. The BAS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN). Workstations can manage a single LAN (or building), and/or the entire system with all portions of that LAN maintaining its own, current database.

E. Standard Network Support

1. All NSCs, Workstation(s) and Servers shall be capable of residing directly on the owner's Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the NSC's, Workstation(s), and Server(s) shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner's Information Systems Department as all devices utilize standard TCP/IP components.

F. System Expansion

1. The BAS system shall be scalable and expandable at all levels of the system using the same software interface, and the same TCP/IP level and fieldbus level controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.
2. Web-based operation shall be supported directly by the NSCs and require no additional software, other than a Java supported network browser.
3. The system shall be capable of using graphical and/or line application programming language for the Network Server Controllers.

G. Support For Open Systems Protocols

1. All Network Server Controllers must natively support the BACnet IP, BACnet MS/TP, LonWorks IP, LonWorks FTT-10, Modbus TCP, Modbus RTU (RS-485 and RS-232), and Modbus ASCII protocols.

2.3 Operator Workstation Requirements

A. General

1. The operator workstation portion of the BAS shall consist of one or more full-powered configuration and programming workstations, and one or more web-based operator workstations. For this project provide (qty) user licenses.

2. The programming and configuration workstation software shall allow any user with adequate permission to create and/or modify any or all parts of the NSC and/or Enterprise Server database.
3. All configuration workstations shall be personal computers operating under the Microsoft Windows 7 operating system. The application software shall be capable of communication to all Network Server Controllers and shall feature high-resolution color graphics, alarming, trend charting. It shall be user configurable for all data collection and data presentation functions.
4. A minimum of 1 Workstation shall be allowed on the Ethernet network. In this client/server configuration, any changes or additions made from one workstation will automatically appear on all other workstations since the changes are accomplished to the databases within the NSC. Systems with a central database will not be acceptable.

B. Administration/Programming Workstation Requirements

1. The workstation shall consist of the following:
 - a. 3 GHz processor with 4GB of RAM
 - b. Microsoft Windows XP 32-bit SP3 or Microsoft Windows 7 operating system
 - c. Serial port, parallel port, USB port
 - d. 10/100MBPS Ethernet NIC
 - e. 80 GB hard disk
 - f. CD-RW drive
 - g. High resolution (minimum 1280 x 1024), 17" flat panel display
 - h. Optical mouse and full function keyboard
 - i. Audio sound card and speakers
 - j. License agreement for all applicable software.

C. Web-Based Operator PC Requirements

1. Any user on the network can access the system, using the following software:
 - a. Windows 2000/XP and above
 - b. Internet Explorer 8.0 and above
 - c. Firefox x.x and above
 - d. Java-enabled

D. General Administration and Programming Workstation Software

1. System architecture shall be truly client server in that the Workstation shall operate as the client while the NSCs shall operate as the servers. The client is responsible for the data presentation and validation of inputs while the server is responsible for data gathering and delivery.
2. The workstation functions shall include monitoring and programming of all DDC controllers. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments.
3. Programming of SDCUs shall be capable of being done either off-line or on-line from any operator workstation. All information will be available in graphic or text displays stored at the NSC. Graphic displays will feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system. All operator functions shall be selectable through a mouse.

E. User Interface:

1. The BAS workstation software shall allow the creation of a custom, browser-style interface linked to the user when logging into any workstation. Additionally, it shall be possible to create customized workspaces that can be assigned to user groups. This

interface shall support the creation of “hot-spots” that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software. Furthermore, this interface must be able to be configured to become a user’s “PC Desktop” – with all the links that a user needs to run other applications. This, along with the Windows user security capabilities, will enable a system administrator to setup workstation accounts that not only limit the capabilities of the user within the BAS software, but may also limit what a user can do on the PC and/or LAN/WAN. This might be used to ensure, for example, that the user of an alarm monitoring workstation is unable to shutdown the active alarm viewer and/or unable to load software onto the PC.

F. User Security

1. The software shall be designed so that each user of the software can have a unique username and password. This username/password combination shall be linked to a set of capabilities within the software, set by and editable only by, a system administrator. The sets of capabilities shall range from View only, Acknowledge alarms, Enable/disable and change values, Program, and Administer. The system shall allow the above capabilities to be applied independently to each and every class of object in the system. The system must allow a minimum of 256 users to be configured per workstation. Additionally, the software shall enable the ability to add/remove users based upon Microsoft Windows Security Domains that enable the customer IT department to assist in user access.

G. Configuration Interface

1. The workstation software shall use a familiar Windows Explorer[®]-style interface for an operator or programmer to view and/or edit any object (controller, point, alarm, report, schedule, etc.) in the entire system. In addition, this interface shall present a “network map” of all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure. All object names shall be alphanumeric and use Windows long filename conventions.
2. The configuration interface shall also include support for user defined object types. These object types shall be used as building blocks for the creation of the BAS database. They shall be created from the base object types within the system input, output, string variables, setpoints, etc., alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs. Groups of user defined object types shall be able to be set up as a predefined aggregate of subsystems and systems. The configuration interface shall support copying/pasting and exporting/importing portions of the database for additional efficiency. The system shall also maintain a link to all “child” objects created. If a user wishes to make a change to a parent object, the software shall ask the user if he/she wants to update all of the child objects with the change.

H. Color Graphic Displays

1. The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse.
2. Requirements of the color graphic subsystem include:
 - a. At a minimum, the user shall have the ability to import .gif, .png, .bmp, .jpeg, .tif, and CAD generated picture files as background displays, and layering shall be possible.

- b. It shall be possible for the user to use JavaScript to customize the behavior of each graphic.
 - c. The editor shall use Scalable Vector Graphics (SVG) technology.
 - d. A built-in library of animated objects such as dampers, fans, pumps, buttons, knobs, gauges, and graphs which can be “dropped” on a graphic through the use of a software configuration “wizard”. These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels.
 - e. Using the mouse, operators shall be able to adjust setpoints, start or stop equipment, modify PID loop parameters, or change schedules.
 - f. Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another.
 - g. Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required.
 - h. It shall be possible to create and save graphical components and JavaScript code in reusable and transferrable, customized libraries.
3. Additionally, the Graphics Editor portion of the Engineering Software shall provide the following capabilities:
- a. Create and save pages.
 - b. Group and ungroup symbols.
 - c. Modify an existing symbol.
 - d. Modify an existing graphic page.
 - e. Rotate and mirror a symbol.
 - f. Place a symbol on a page.
 - g. Place analog dynamic data in decimal format on a page.
 - h. Place binary dynamic data using state descriptors on a page.
 - i. Create motion through the use of animated .gif files or JavaScript.
 - j. Place test mode indication on a page.
 - k. Place manual mode indication on a page.
 - l. Place links using a fixed symbol or flyover on a page.
 - m. Links to other graphics.
 - n. Links to web sites.
 - o. Links to notes.
 - p. Links to time schedules.
 - q. Links to any .exe file on the operator work station.
 - r. Links to .doc files.
 - s. Assign a background color.
 - t. Assign a foreground color.
 - u. Place alarm indicators on a page.
 - v. Change symbol/text/value color as a function of an analog variable.
 - w. Change a symbol/text/value color as a function of a binary state.
 - x. Change symbol/text/value as a function of a binary state.
 - y. All symbols used by Schneider Electric Buildings Business in the creation of graphic pages shall be saved to a library file for use by the owner.
- I. Automatic monitoring
- 1. The software shall allow for the automatic collection of data and reporting from any controller or NSC. The frequency of data collection shall be user-configurable.

J. Alarm Management

1. The software shall be capable of accepting alarms directly from NSCs or controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, or reports.
2. Alarm management features shall include:
 - a. A minimum of 1000 alarm notification levels. Each notification level will establish a unique set of parameters for controlling alarm display, distribution, acknowledgment, keyboard annunciation, and record keeping.
 - b. Automatic logging in the database of the alarm message, point name, point value, source device, timestamp of alarm, username and time of acknowledgement, username and time of alarm silence (soft acknowledgement)
 - c. Playing an audible sound on alarm initiation or return to normal.
 - d. Sending an email or alphanumeric pager to anyone listed in a workstation's email account address list on either the initial occurrence of an alarm and/or if the alarm is repeated because an operator has not acknowledged the alarm within a user-configurable timeframe. The ability to utilize email and alphanumeric paging of alarms shall be a standard feature of the software integrated with the operating system's mail application interface (MAPI). No special software interfaces shall be required and no email client software must be running in order for email to be distributed.
 - e. Individual alarms shall be able to be re-routed to a user at user-specified times and dates. For example, a critical high temp alarm can be configured to be routed to a Facilities Dept. workstation during normal working hours (7am-6pm, Mon-Fri) and to a Central Alarming workstation at all other times.
 - f. It shall be possible to re-route an alarm if a user-defined response time has been exceeded. For example, if a critical alarm has an acknowledgment time of 5 minutes and that acknowledgement does not occur, the alarm can be re-routed to a secondary receiver.
 - g. An active alarm viewer shall be included which can be customized for each user or user type to hide or display any alarm attributes.
 - h. The font type and color, and background color for each alarm notification level as seen in the active alarm viewer shall be customizable to allow easy identification of certain alarm types or alarm states.
 - i. The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of user actions for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.
 - j. The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of causes for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.
 - k. The active alarm viewer can be configured such that an operator must confirm that all of the steps in a check list have been accomplished prior to acknowledging the alarm.
 - l. An operator shall have the capability to assign an alarm to another user of the system. Such assignments shall be tracked to insure alarm response.

K. Report Generation

1. The Reports Server shall be able to process large amounts of data and produce meaningful reports to facilitate analysis and optimization of each installation.

2. Reports shall be possible to generate and view from the operator Workstation, and/or Webstation, and/or directly from a reports-only web interface.
3. A library of predefined automatically generated reports that prompt users for input prior to generation shall be available. The properties and configurations made to these reports shall be possible to save as Dashboard reports, so that the configurations are saved for future used.
4. It shall be possible to create reports standard tools, such as Microsoft Report Builder 2.0 or Visual Studio, shall be used for customized reports.
5. Additional reports or sets of reports shall be downloadable, transferrable, and importable
6. All reports shall be able to be set up to automatically run or be generated on demand.
7. Each report shall be capable of being automatically emailed to a recipient in Microsoft Word, Excel, and/or Adobe .pdf format.
8. Reports can be of any length and contain any point attributes from any controller on the network.
9. Image management functionality shall be possible to enable the system administrators to easily upload new logos or images to the system.
10. It shall be possible to run other executable programs whenever a report is initiated.
11. Report Generator activity can be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition.
12. Minimum supplied reports shall include:
 - a. Points in each controller
 - b. Points in alarm
 - c. Disabled points
 - d. Overridden points
 - e. Operator activity report
 - f. Alarm history log
 - g. Program listing by controller with status
 - h. Network status of each controller
 - i. Activities Per Server Report
 - j. Activities Per User Report
 - k. Alarm Amount by Category Report
 - l. Alarm Amount by Type Report
 - m. Alarms Per Sever Report
 - n. Current Alarm Report
 - o. Most Active Alarm Report
 - p. System Errors Per Server Report
 - q. Top Activities Report
 - r. Top Alarms Report
 - s. Top System Errors Report
 - t. Trend Log Comparison Report
 - u. User Logins Report
 - v. Users and Groups Reports
13. Minimum Energy Reports shall include:
 - a. Energy Monitoring Calendar Consumption Report: Shall provide an interactive report that shows the energy usage on one or multiple selected days.
 - b. Energy Monitoring Consumption Breakdown Report: Shall provide a report on energy consumption broken down using sub-metering.
 - c. Energy Monitoring Consumption Report: Shall show the energy consumption against a specified target value.

14. Reports Server Software Requirements
 - a. Microsoft Windows Server 2008 32-bit or Windows 7 32-bit
 - b. Microsoft SQL Server 2008 with Advanced Services
 - c. Microsoft Net 3.5 SP1

L. Scheduling

1. From the workstation or webstation, it shall be possible to configure and download schedules for any of the controllers on the network.
2. Time of day schedules shall be in a calendar style and viewable in both a graphical and tabular view.
3. Schedules shall be programmable for a minimum of one year in advance.
4. To change the schedule for a particular day, a user shall simply select the day and make the desired modifications.
5. Additionally, from the operator webstations, each schedule will appear on the screen viewable as the entire year, monthly, week and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one month to the next and view or alter any of the schedule times.
6. Schedules will be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation will be automatically updated to the corresponding schedule in the controller.
7. It shall be possible to assign a lead schedule such that shadow/local schedules are updated based upon changes in the Lead.
8. It shall be possible to assign a list(s) of exception event days, dates, date ranges to a schedule.

M. Programmer's Environment

1. Programming in the NSC shall be either in graphical block format or line-programming format or both.
2. The programmer's environment will include access to a superset of the same programming language supported in the SDCUs.
3. NSC devices will support both script programming language as well as the graphical function block programming language. For both languages, the programmer will be able to configure application software off-line (if desired) for custom program development, and write global control programs.
4. It shall be possible to save custom programs as libraries for reuse throughout the system. A wizard tool shall be available for loading programs from a library file in the program editor.
5. It shall be possible to view graphical programming live and real-time from the Workstation.

N. Saving/Reloading

1. The workstation software shall have an application to save and restore NSC and field controller memory files.
2. For the NSC, this application shall not be limited to saving and reloading an entire controller – it must also be able to save/reload individual objects in the controller. This allows off-line debugging of control programs, for example, and then reloading of just the modified information.

O. Audit Trail

1. The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.

2. It shall be possible to view a history of alarms, user actions, and commands for any system object individually or at least the last 5000 records of all events for the entire system from Workstation.
3. It shall be possible to save custom filtered views of event information that are viewable and configurable in Workstation.

P. Fault Tolerant Enterprise Server Operation (Top level NSC)

1. A single component failure in the system shall not cause the entire system to fail. All system users shall be informed of any detectable component failure via an alarm event. System users shall not be logged off as a result of a system failure or switchover.

Q. Web-based Operator Software

1. General:
 - a. Day-to-day operation of the system shall be accessible through a standard web browser interface, allowing technicians and operators to view any part of the system from anywhere on the network.
2. Graphic Displays
 - a. The browser-based interface must share the same graphical displays as the Administration and Programming Workstations, presenting dynamic data on site layouts, floor plans, and equipment graphics. The browser's graphics shall support commands to change setpoints, enable/disable equipment and start/stop equipment.
 - b. Through the browser interface, operators must be able to navigate through the entire system, and change the value or status of any point in any controller. Changes are effective immediately to the controller, with a record of the change stored in the system database.
3. Alarm Management
 - a. Systems requiring additional client software to be installed on a PC for viewing the webstation from that PC will not be considered.
 - b. Through the browser interface, a live alarm viewer identical to the alarm viewer on the Administration and Programming workstation shall be presented, if the user's password allows it. Users must be able to receive alarms, silence alarms, and acknowledge alarms through a browser. If desired, specific operator text must be able to be added to the alarm record before acknowledgement, attachments shall be viewable, and alarm checklists shall be available.

R. Groups and Schedules

1. Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.
2. Through the browser interface, operators must be able to change schedules – change start and stop times, add new times to a schedule, and modify calendars.

S. User Accounts and Audit Trail

1. The same user accounts shall be used for the browser interface and for the operator workstations. Operators must not be forced to memorize multiple passwords.
2. All commands and user activity through the browser interface shall be recorded in the system's activity log, which can be later searched and retrieved by user, date, or both.

2.4 Network Server Controllers (NSCs)

- A. Network Router Controllers shall combine both network routing functions, control functions, and server functions into a single unit.

- B. The BACnet NSC shall be classified as a “native” BACnet device, supporting the BACnet Network Server Controller (B-BC) profile. Controllers that support a lesser profile such as B-SA are not acceptable. NSCs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Network Server Controllers (B-BC).
- C. The Network Server Controller shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NRS.
- D. They shall also be responsible for monitoring and controlling their own HVAC equipment such as an AHU or boiler.
- E. They shall also contain graphics, trends, trend charts, alarm views, and other similar presentation objects that can be served to workstations or web-based interfaces. A sufficient number of NSCs shall be supplied to fully meet the requirements of this specification and the attached point list.
- F. It shall be capable of executing application control programs to provide:
 - 1. Calendar functions
 - 2. Scheduling
 - 3. Trending
 - 4. Alarm monitoring and routing
 - 5. Time synchronization by means of an Internet site including automatic synchronization
 - 6. Native integration of LonWorks controller data and Modbus controller data or BACnet controller data and Modbus controller data
 - 7. Network Management functions for all LonWorks based devices
- G. Hardware Specifications
 - 1. Memory:
 - a. The operating system of the controller, application programs, and all other portions of the configuration database, shall be stored in non-volatile, FLASH memory. Servers/Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.
 - 2. Each NRC shall provide the following on-board hardware for communication:
 - a. One 10/100bT Ethernet for communication to Workstations, other NRCs and onto the Internet
 - b. Two RS-485 ports for communication to BACnet MSTP bus or serial Modbus (software configurable)
 - c. One TP/FT port for communication to LonWorks devices.
 - d. One Device USB port
 - e. Two host USB Ports
- H. Modular Expandability:
 - 1. The system shall employ a modular I/O design to allow expansion. Input and output capacity is to be provided through plug-in modules of various types. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.
- I. Hardware Override Switches:
 - 1. All digital outputs shall, optionally, include three position manual override switches to allow selection of the ON, OFF, or AUTO output state. These switches shall be built into the unit and shall provide feedback to the controller so that the position of the override switch can be obtained through software. In addition each analog output shall be equipped with an override potentiometer to allow manual adjustment of the analog output signal over its full range, when the 3 position manual override switch is placed in the ON position.

J. Local Status Indicator Lamps:

1. The NSC shall provide as a minimum LED indication of CPU status, Ethernet LAN status, and field bus status. For each input or output, provide LED indication of the value of the point (On/Off). The LED indication shall support software configuration to set whether the illumination of the LED corresponds to On or Off or whether the color when illuminated is Red or Green.

K. Real Time Clock (RTC):

1. Each NSC shall include a battery-backed, real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day, month, year, and day of week. Each NSC will allow for its own UTC offset, depending upon the time zone. When the time zone is set, the NSC will also store the appropriate times for daylight savings time.

L. Power Supply:

1. The 24 VDC power supply for the NSCs shall provide 30 watts of available power for the NSC and associated IO modules. The system shall support the use of more than one power supply if heavily power consuming modules are required.

M. Automatic Restart After Power Failure:

1. Upon restoration of power after an outage, the NSC shall automatically and without human intervention update all monitored functions, resume operation based on current, synchronize time and status, and implement special start-up strategies as required.

N. Battery backup:

1. The NSC shall include an on-board battery to back up the controller's RAM memory. The battery shall provide accumulated backup of all RAM and clock functions for at least 30 days. In the case of a power failure, the NSC shall first try to restart from the RAM memory. If that memory is corrupted or unusable, then the NSC shall restart itself from its application program stored in its FLASH memory.

O. Software Specifications

1. The operating system of the controller, application programs, and all other portions of the configuration database such as graphics, trends, alarms, views, etc., shall be stored in non-volatile, FLASH memory. There will be no restrictions placed on the type of application programs in the system. Each NSC shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.
2. Each NSC shall have an available capacity of 4 GB of memory. This shall represent 2 GB for application and historical data and 2 GB dedicated for backup storage.

P. User Programming Language:

1. The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be either a script-based structured text or graphical function block based and fully programmable by the user. The language shall be structured to allow for the configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, and histories. Users shall be able to place comments anywhere in the body of either script or function block programs.
2. Network Server Controllers that use a "canned" program method will not be accepted.

Q. Control Software:

1. The NSC shall have the ability to perform the following pre-tested control algorithms:
 - a. Proportional, Integral plus Derivative Control (PID)
 - b. Two Position Control
 - c. Digital Filter
 - d. Ratio Calculator
 - e. Equipment Cycling Protection

R. Mathematical Functions:

1. Each controller shall be capable of performing basic mathematical functions (+, -, *, /), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both. The controllers shall be capable of performing complex logical statements including operators such as >, <, =, and, or, exclusive or, etc. These must be able to be used in the same equations with the mathematical operators and nested up to five parentheses deep.

S. NSCs shall have the ability to perform any or all of the following energy management routines:

1. Time of Day Scheduling
2. Calendar Based Scheduling
3. Holiday Scheduling
4. Temporary Schedule Overrides
5. Optimal Start
6. Optimal Stop
7. Night Setback Control
8. Enthalpy Switchover (Economizer)
9. Peak Demand Limiting
10. Temperature Compensated Duty Cycling
11. CFM Tracking
12. Heating/Cooling Interlock
13. Hot/Cold Deck Reset
14. Hot Water Reset
15. Chilled Water Reset
16. Condenser Water Reset
17. Chiller Sequencing

T. History Logging:

1. Each NSC controller shall be capable of LOCALLY logging any input, output, calculated value or other system variable either over user defined time intervals ranging from 1 second to 1440 minutes or based upon a user configurable change of value. A minimum of 1000 values shall be stored in each of these types of logs. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to a higher level NSC long term archiving based upon user-defined time intervals, or manual command.
2. Management of a power meter replacement to ensure meter log data is accurate shall be possible in the NSC.
3. Every hardware input and output point shall be trended automatically without the requirement for manual creation, and each of these logs shall log values based upon a change of value and store at least 500 trend samples before replacing the oldest sample with new data.
4. The presentation of logged data shall be built into the server capabilities of the NSC. Presentation can be in time stamped list formats or in a chart format with fully configurable pen colors, weights, scales and time spans.

U. Alarm Management:

1. For each system point, alarms can be created based on high/low limits or in comparison to other point values. All alarms will be tested each scan of the NSC and can result in the display of one or more alarm messages or reports.
2. There is no limit to the number of alarms that can be created for any point/
3. Alarms can be configured to be generated based upon a single system condition or multiple system conditions.
4. Alarms will be generated based on an evaluation of the alarm conditions and can be presented to the user in a fully configurable order, by priority, by time, by category, etc. These configurable alarm views will be presented to a user upon logging into the system regardless of whether the log in takes place at a WorkStation or a Webstation.
5. The alarm management system shall support the ability to create and select cause and action notes to be selected and associated with an alarm event. Checklists shall also be possible in order to present to an operator a suggested mode of troubleshooting. When acknowledging an alarm, it shall be possible to assign it to a user of the system such that the user is notified of the assignment and is made responsible for the alarm resolution.
6. Alarms must be capable of being routed to any BACnet workstation that conforms to the B-OWS device profile and uses the BACnet/IP protocol.

V. Embedded Web Server

1. Each NSC must have the ability to serve out web pages containing the same information that is available from the WorkStation. The development of the screens to accomplish shall not require any additional engineering labor over that required to show them at the WorkStation itself.

2.5 Enterprise Server Hardware Requirements

- A. Processor: 2 GHz or higher
- B. Memory: 4 GB
- C. Hard-Disk Drive: 20 GB
- D. Embedded Intel PRO/100+ Server Adapter for TCP/IP Communication
- E. DVD-ROM Drive: 24X, IDE CD-ROM with software decoding.
- F. Operating System: Microsoft Windows XP 32-bit SP3, Windows 7 32-bit, Server 2008 32 bit.

2.6 LON Fieldbus and LON SDCUs

A. IP Network

1. All devices that connect to the WAN shall be capable of operating at 10 megabits per second and 100 megabits per second

B. Field Bus

1. The field busses shall be FTT-10A operating at 78 kilobits per second.
2. The wiring of components shall use a bus or daisy chain concept with no tees, stubs or free topology.
3. The wiring type and length limitations shall conform to Echelon's Junction Box and Wiring Guideline for Twisted Pair LonWorks Networks.
4. Each field bus shall have a termination device at both ends of each segment.

C. IP to Field Bus Router

1. These devices shall perform layer 3 routing of ANSI/EIA 709.1B packets onto the IP network.
2. These devices shall be configurable locally without the use of the IP network (local cross over cable connection is acceptable) and configurable via the IP network.
3. These devices shall be configurable as routers such that only data packets from the field bus devices that need to travel over the IP level of the architecture are forwarded.

D. Network Server Controller

1. These devices shall perform layer 3 routing of ANSI/EIA 709.1B packets onto the IP network.
2. These devices shall be configurable locally without the use of the IP network (local cross over cable connection is acceptable) and configurable via the IP network.
3. These devices shall be configurable as routers such that only data packets from the field bus devices that need to travel over the IP level of the architecture are forwarded.
4. These devices shall provide the following support for the field bus devices that are connected below the Network Server Controller.
 - a. Time schedules
 - b. Trend logging
 - c. Alarm message generation and handling
5. These devices may provide supervisory logic support for the field bus devices that are connected below the Network Server Controller.
6. These devices may have physical inputs and outputs and provide process control for systems using these inputs and outputs.
7. If a Network Server Controller has physical inputs and outputs, it shall also comply with all of the requirements for programmable process controllers.

E. Physical Layer Repeaters (PLR)

1. PLRs are required to connect two segments to create a channel.
2. The design of the PLRs shall conform to LONMark standards.
3. LON to LON routers configured as repeaters may be used as a PLR.
4. Physical layer repeaters shall be installed in an enclosure. The enclosure may be in an interstitial space.

F. Standalone Digital Control Units (SDCUs)

1. General Requirements
 - a. Devices shall incorporate a service pin which, when pressed, will cause the device to broadcast its 48 bit node ID and its program ID over the network. The service pin shall be distinguishable and accessible.
 - b. Devices shall have a light indicating that they are powered.
 - c. Devices shall incorporate a TP/FT-10A transceiver in accordance with ANSI/EIA 709.3 and connections for TP/FT control network wiring.
 - d. Devices shall be locally powered. Link powered devices are not acceptable.
 - e. Application programs shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration parameter settings.
2. Programmable Process Controllers (PPC)
 - a. The key characteristics of a PPC are:

- 1) They have physical input and output circuits for the connection of analog input devices, binary input devices, pulse input devices, analog output devices and binary output devices. The number and type of input and output devices supported will vary by model.
 - 2) They may or may not provide support for additional input and output devices beyond the number of circuits that are provided on the basic circuit board. Support for additional I/O may be by additional circuit boards that physically connect to the basic controller or by a standalone device that communicates with the basic controller via the FTT-10A field bus.
 - 3) The application to be executed by a PPC is created by an application engineer using the vendor's application programming tool.
 - 4) PPCs shall support embedded time schedules. When time schedules are not embedded in a PPC, an occupancy command shall be an input network variable when time based control is required by the sequence of control. Systems that use a Network Server Controller shall provide time schedule support in the Network Server Controller and the PPCs are not required to support for time schedules. Systems that use LON to IP routers require that PPCs support embedded time schedules.
 - 5) PPCs shall, support trend data storage with periodic upload to the data server. When trend data storage is not supported, the variables to be trended shall be broadcast over the field bus to another device that does support embedded trend data storage. Systems that use a Network Server Controller shall provide trend logging support in the Network Server Controller and the PPCs are not required to support trend logging. Systems that use LON to IP routers require that PPCs support embedded trend logging.
 - 6) PPCs shall, support the initiation of an alarm message to the system server. When alarm message initiation is not supported, binary alarm indication variables shall be broadcast over the field bus to another device that does support the initiation of alarm messages to the system server. Systems that use a Network Server Controller shall provide alarm message initiation support in the Network Server Controller and the PPCs are not required to support alarm message initiation. Systems that use LON to IP routers require that PPCs support alarm messaging initiation.
- b. Analog Input Circuits
- 1) The electrical signals from analog sensors shall be processed by an analog to digital (A/D) converter chip. The output of the A/D chip shall then be processed mathematically to produce data within the controller that has the required engineering units.
 - 2) The resolution of the A/D chip shall not be greater than 0.01 Volts per increment. For an A/D converter that has a measurement range of 0 to 10 VDC and is 10 bit, the resolution is 10/1024 or 0.00976 Volts per increment.
 - 3) For non-flow sensors, the control logic shall provide support for the use of a calibration offset such that the raw measured value is added to the (+/-) offset to create a calibration value to be used by the control logic and reported to the Operator Workstation (OWS).
 - 4) For flow sensors, the control logic shall provide support for the use of an adjustable gain and an adjustable offset such that a two point calibration concept can be executed (both a low range value and a high range value are adjusted to match values determined by a calibration instrument).

- 5) For non-linear sensors such as thermistors and flow sensors the PPC shall provide software support for the linearization of the input signal.
- c. Binary Input Circuits
 - 1) Dry contact sensors shall wire to the controller with two wires.
 - 2) An external power supply in the sensor circuit shall not be required.
- d. Pulse Input Circuits
 - 1) Pulse input sensors shall wire to the controller with two wires.
 - 2) An external power supply in the sensor circuit shall not be required.
 - 3) The pulse input circuit shall be able to process up to 50 pulses per second.
- e. True Analog Output Circuits
 - 1) The logical commands shall be processed by a digital to analog (D/A) converter chip. The 0% to 100% control signal shall be scalable to the full output range which shall be either 0 to 10 VDC, 4 to 20 milliamps or 0 to 20 milliamps or to ranges within the full output range (Example: 0 to 100% creates 3 to 6 VDC where the full output range is 0 to 10 VDC).
 - 2) The resolution of the D/A chip shall not be greater than 0.04 Volts per increment or 0.08 milliamps per increment.
- f. Pulse Width Modulation Outputs with PWM transducers
 - 1) The controller shall be able to generate incremental pulses as small as 0.1 seconds.
- g. Binary Output Circuits
 - 1) Single pole single throw or single pole double throw relays with support for up to 230 VAC and a maximum current of 2 amps.
 - 2) Voltage sourcing or externally powered triacs with support for up to 30 VAC and 0.8 amps.
- h. Program Execution
 - 1) Process control loops shall operate in parallel and not in sequence unless specifically required to operate in sequence by the sequence of control.
 - 2) The sample rate for a process control loop shall be adjustable and shall support a minimum sample rate of 1 second.
 - 3) The sample rate for process variables shall be adjustable and shall support a minimum sample rate of 1 second.
 - 4) The sample rate for algorithm updates shall be adjustable and shall support a minimum sample rate of 1 second.
 - 5) The application shall have the ability to determine if a power cycle to the controller has occurred, and the application programmer shall be able to use the indication of a power cycle to modify the sequence of control immediately following a power cycle.
- i. Local Interface: The controller shall support the connection of a portable interface device such as a laptop computer or vendor unique hand-held device. The ability to execute any tasks other than viewing data shall be password protected. Via this local interface, an operator shall be able to:
 - 1) Adjust application parameters.
 - 2) Edit time schedule parameters if time schedules are embedded in the controller.
 - 3) Execute manual control of input and output points.
 - 4) View dynamic data.
 - 5) View alarm messages if alarm messaging is embedded in the controller.

- j. Each PPC shall have a network interface port that allows for an external device to connect to the FTT-10A network by plugging into the port. This port shall be built into the controller.
- 3. Supervisory Logic Controller (SLC)
 - a. The key characteristics of an SLC are:
 - 1) The application to be executed by as SLC is created by an application engineer using the vendor's application programming tool.
 - 2) SLCs shall support embedded time schedules. When time schedules are not embedded in a SLC, an occupancy command shall be an input network variable when time based control is required by the sequence of control. Systems that use a Network Server Controller shall provide time schedule support in the Network Server Controller and the SLCs do not have to support for time schedules. Systems that use a LON to IP router will provide time schedule support in the SLCs.
 - 3) SLCs shall support trend data storage with periodic upload to the data server. When trend data storage is not supported, the variables to be trended shall be broadcast over the field bus to another device that does support embedded trend data storage. Systems that use a Network Server Controller shall provide trend logging support in the Network Server Controller and the SLCs are not required to support trend logging. Systems that use LON to IP routers require that SLCs support embedded trend logging.
 - 4) SLCs shall support the initiation of an alarm message to the system server. When alarm message initiation is not supported, binary alarm indication variables shall be broadcast over the field bus to another device that does support the initiation of alarm messages to the system server. Systems that use a Network Server Controller shall provide alarm message initiation support in the Network Server Controller and the SLCs are not required to support alarm message initiation. Systems that use LON to IP routers require that SLCs support alarm messaging initiation.
 - b. Program Execution
 - 1) Control algorithms shall operate in parallel and not in sequence unless specifically required to operate in sequence by the sequence of control.
 - 2) The sample rate for algorithm updates shall be adjustable and shall support a minimum sample rate of 1 second.
 - 3) The application shall have the ability to determine if a power cycle to the controller has occurred and the application programmer shall be able to use the indication of a power cycle to modify the sequence of control immediately following a power cycle.
 - c. Local Interface
 - 1) The controller shall support the connection of a portable interface device such as a laptop computer or vendor unique hand-held device. The ability to execute any tasks other than viewing data shall be password protected. Via this local interface, an operator shall be able to:
 - a) Adjust application parameters.
 - b) Edit time schedule parameters if time schedules are embedded in the controller.
 - c) Execute manual control of input and output network variables.
 - d) View dynamic data.

- e) View alarm messages if alarm messaging is embedded in the controller.
 - d. Each SLC shall have a network interface port that allows for an external device to connect to the FTT-10A network by plugging into the port. This port shall be built into the controller.
 - e. Programmable Process Controllers (PPCs) with un-used I/O may be used as Supervisory Logic Controllers provided they meet all other requirements.
 - f. Supervisory logic controllers shall have support a minimum of 200 input network variables and 70 output network variables.
 - 1) The SNVT for each of the 200 input network variables shall be selectable.
 - 2) The SNVT for each of the 70 output network variables shall be selectable.
 - g. For the input and output network variables there shall not be any limitations as to the SNVT selected. (Example: SNVT_temp_p can only be used on 10 input network variables.)
- 4. Application Specific Devices (ASD)
 - a. ASD shall have fixed function configurable applications.
 - b. If the application can be altered by the vendor's application programming tool, the device is a programmable controller and not an application specific device.
 - c. All input and output network variables shall be formatted with SNVTs.
 - d. All input configuration parameters shall be formatted with SNVTs or SCPTs. If UNVTs or UCPTs are used, the device resource files that allow these custom parameters to be read shall be provided to the owner.
 - e. The network interface shall conform to the LonMark profile for the application provided by the ASD.
 - f. Each ASD shall have a network interface port that allows for an external device to connect to the FTT-10A network by plugging into the port. This port shall be built into the controller.
- 5. Portable Operating Terminals (POT)
 - a. Laptop Computer
 - b. 3GHz Pentium 4 processor with 1GB of RAM
 - c. Serial port, parallel port and 4 USB ports
 - d. 2 PCMCIA Slots
 - e. 10/100 MBS Ethernet network interface
 - f. 40GB Hard Disk
 - g. CD-RW drive
 - h. Touchpad mouse functionality
 - i. Software Requirements: The software requirements for a POT are identical to those for an operator workstation.

2.7 BACnet Fieldbus and BACnet SDCUs

A. Networking

- 1. IP Network: All devices that connect to the WAN shall be capable of operating at 10 megabits per second or 100 megabits per second.
- 2. IP To Field Bus Routing Devices
 - a. A Network Server Controller shall be used to provide this functionality.
 - b. These devices shall be configurable locally with IP crossover cable and configurable via the IP network.

- c. The routing configuration shall be such that only data packets from the field bus devices that need to travel over the IP level of the architecture are forwarded.

B. Field Bus Wiring and Termination

- 1. The wiring of components shall use a bus or daisy chain concept with no tees, stubs, or free topology.
- 2. Each field bus shall have a termination resistor at both ends of each segment.
- 3. The field bus shall support the use of wireless communications.

C. Repeaters

- 1. Repeaters are required to connect two segments.
- 2. Repeaters shall be installed in an enclosure. The enclosure may be in an interstitial space.

D. Field Bus Devices

- 1. General Requirements
 - a. Devices shall have a light indicating that they are powered.
 - b. Devices shall be locally powered. Link powered devices (power is furnished from a central source over the field bus cable) are not acceptable.
 - c. Application programs shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration parameter settings. (Battery backup, flash memory, etc.)

E. Network Server Controllers (NSCs)

- a. If NSCs have embedded I/O, all of the requirements for I/O that are described under Advance Application Controllers shall apply.
- b. Shall support the export of data to NSCs from other vendors that support the data sharing, read property service.
- c. Shall support the export of data using Change of Value (COV) initiation to NSCs from other vendors that support the subscription to data using the COV concept.
- d. Shall support the export of data to any BACnet OWS that supports the data sharing, read property service.
- e. Shall support the export of data using Change of Value (COV) initiation to any BACnet OWS that supports the subscription to data using the COV concept.
- f. Shall provide trend log support for all of the devices on the field bus. They shall provide sufficient memory to store up to 300 samples for each variable required to be trended by the sequence of control.
- g. Shall support the exporting of trend log data to any BACnet OWS that supports the read range BACnet service for trending.
- h. Shall provide time schedule support for all of the devices on the field bus.
- i. Shall support the editing of time schedule entries from any BACnet OWS that supports the BACnet service for writing of time schedule parameters.
- j. Shall provide alarm message initiation for all alarms conditions from any of the field bus devices.
- k. Shall deliver alarm messages to any BACnet OWS that supports the BACnet service for receiving alarm messages and is configured to be a recipient of the notification.
- l. Shall support alarm acknowledgement from any BACnet OWS that supports the BACnet service for executing alarm/event acknowledgement.
- m. Shall support the control of the out of service property and assignment of value or state to analog and binary objects from any BACnet OWS that

supports writing to the out of service property and the value property of analog and binary objects.

- n. Shall support the receipt and response to Time Synchronization commands from any device that supports the BACnet service for initiating time synchronization commands.
- o. Shall support the "Who is?" and "I am." BACnet service.
- p. Shall support the ""Who has?" and "I have." BACnet service.
- q. Shall support Backup and Restore commands from any BACnet OWS that supports the initiation of Backup and Restore commands.
- r. Shall be BTL certified.

F. Advance Application Controllers (B-AAC)

1. The key characteristics of a B-AAC are:
 - a. They have physical input and output circuits for the connection of analog input devices, binary input devices, pulse input devices, analog output devices, and binary output devices. The number and type of input and output devices supported will vary by model.
 - b. They may or may not provide support for additional input and output devices beyond the number of circuits that are provided on the basic circuit board. Support for additional I/O shall be provided by additional circuit boards that physically connect to the basic controller.
 - c. The application to be executed by a B-AAC is created by an application engineer using the vendor's application programming tool.
 - d. If local time schedules are embedded, the B-AAC shall support the editing of time schedule entries from any BACnet OWS that supports the BACnet service for writing of time schedule parameters.
 - e. If local trend logging is embedded, the B-AAC shall support the exporting of trend log data to any BACnet OWS that supports the read range BACnet service for trending.
 - f. If local alarm message initiation is embedded, the B-AAC shall:
 - 1) Deliver alarm messages to any BACnet OWS that supports the BACnet service for receiving alarm messages and is configured to be a recipient off the alarm message.
 - 2) Support alarm acknowledgement from any BACnet OWS that supports the BACnet service for executing alarm/event acknowledgement,
 - g. Shall support the reading of analog and binary data from any BACnet OWS or Building Controller that supports the BACnet service for the reading of data.
 - h. Shall support the control of the out of service property and assignment of value or state to analog and binary objects from any BACnet OWS that supports writing to the out of service property and the value property of analog and binary objects.
 - i. Shall support the receipt and response to Time Synchronization commands from a BACnet Building Controller.
 - j. Shall support the "Who is" and "I am." BACnet services.
 - k. Shall support the "Who has" and "I have." BACnet services.
2. Analog Input Circuits
 - a. The resolution of the A/D chip shall not be greater than 0.01 Volts per increment. For an A/D converter that has a measurement range of 0 to 10 VDC and is 10 bit, the resolution is 10/1024 or 0.00976 Volts per increment.
 - b. For non-flow sensors, the control logic shall provide support for the use of a calibration offset such that the raw measured value is added to the (+/-) offset

- to create a calibration value to be used by the control logic and reported to the Operator Workstation (OWS).
 - c. For flow sensors, the control logic shall provide support for the use of an adjustable gain and an adjustable offset such that a two point calibration concept can be executed (both a low range value and a high range value are adjusted to match values determined by a calibration instrument).
 - d. For non-linear sensors such as thermistors and flow sensors the B-AAC shall provide software support for the linearization of the input signal.
- 3. Binary Input Circuits
 - a. Dry contact sensors shall wire to the controller with two wires.
 - b. An external power supply in the sensor circuit shall not be required.
- 4. Pulse Input Circuits
 - a. Pulse input sensors shall wire to the controller with two wires.
 - b. An external power supply in the sensor circuit shall not be required.
 - c. The pulse input circuit shall be able to process up to 20 pulses per second.
- 5. True Analog Output Circuits
 - a. The logical commands shall be processed by a digital to analog (D/A) converter chip. The 0% to 100% control signal shall be scalable to the full output range which shall be either 0 to 10 VDC, 4 to 20 milliamps or 0 to 20 milliamps or to ranges within the full output range (Example: 0 to 100% creates 3 to 6 VDC where the full output range is 0 to 10 VDC).
 - b. The resolution of the D/A chip shall not be greater than 0.04 Volts per increment or 0.08 milliamps per increment.
- 6. Binary Output Circuits
 - a. Single pole, single throw or single pole, double throw relays with support for up to 230 VAC and a maximum current of 2 amps.
 - b. Voltage sourcing or externally powered triacs with support for up to 30 VAC and 0.5 amps at 24 VAC.
- 7. Program Execution
 - a. Process control loops shall operate in parallel and not in sequence unless specifically required to operate in sequence by the sequence of control.
 - b. The sample rate for a process control loop shall be adjustable and shall support a minimum sample rate of 1 second.
 - c. The sample rate for process variables shall be adjustable and shall support a minimum sample rate of 1 second.
 - d. The sample rate for algorithm updates shall be adjustable and shall support a minimum sample rate of 1 second.
 - e. The application shall have the ability to determine if a power cycle to the controller has occurred and the application programmer shall be able to use the indication of a power cycle to modify the sequence of controller immediately following a power cycle.
- 8. Local Interface
 - a. The controller shall support the connection of a portable interface device such as a laptop computer or vendor unique hand-held device. The ability to execute any tasks other than viewing data shall be password protected. Via this local interface, an operator shall be able to:
 - 1) Adjust application parameters.
 - 2) Execute manual control of input and output points.
 - 3) View dynamic data.

G.Application Specific Devices

1. Application specific devices shall have fixed function configurable applications.
2. If the application can be altered by the vendor's application programmable tool, the device is an advanced application controller and not an application specific device.
3. Application specific devices shall be BTL certified.

2.8 DDC Sensors and Point Hardware

A. Temperature Sensors

1. All temperature devices shall use precision thermistors accurate to ± 1 degree F over a range of -30 to 230 degrees F. Space temperature sensors shall be accurate to $\pm .5$ degrees F over a range of 40 to 100 degrees F.
2. Standard space sensors shall be available in an off white enclosure for mounting on a standard electrical box.
3. Where manual overrides are required, the sensor housing shall feature both an optional sliding mechanism for adjusting the space temperature setpoint, as well as a push button for selecting after hours operation.
4. Where a local display is specified, the sensor shall incorporate either an LED or LCD display for viewing the space temperature, setpoint and other operator selectable parameters. Using built in buttons, operators shall be able to adjust setpoints directly from the sensor.
5. Duct temperature sensors shall incorporate a thermistor bead embedded at the tip of a stainless steel tube. Probe style duct sensors are useable in air handling applications where the coil or duct area is less than 14 square feet.
6. Averaging sensors shall be employed in ducts which are larger than 14 square feet. The averaging sensor tube must contain at least one thermistor for every 3 feet, with a minimum tube length of 12 feet.
7. Immersion sensors shall be employed for measurement of temperature in all chilled and hot water applications as well as refrigerant applications. Thermal wells shall be brass or stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications.
8. A pneumatic signal shall not be allowed for sensing temperature.

B. Humidity Sensors

1. Humidity devices shall be accurate to $\pm 5\%$ at full scale for space and $\pm 3\%$ for duct and outside air applications. Suppliers shall be able to demonstrate that accuracy is NIST traceable.
2. As an option, provide a hand held field calibration tool that both reads the output of the sensor and contains a reference sensor for ongoing calibration.

C. Pressure Sensors

1. Air pressure measurements in the range of 0 to $10''$ water column will be accurate to $\pm 1\%$ using a solid-state sensing element. Acceptable manufacturers include Modus Instruments and Mamac.
2. Differential pressure measurements of liquids or gases shall be accurate to $\pm 0.5\%$ of range. The housing shall be Nema 4 rated.

D. Current and KW Sensors

1. Current status switches shall be used to monitor fans, pumps, motors and electrical loads. Current switches shall be available in solid and split core models, and offer either a digital or an analog signal to the automation system. Acceptable manufacturer is Veris or approved equal.
2. Measurement of three phase power shall be accomplished with a kW/kWH transducer. This device shall utilize direct current transformer inputs to calculate the

instantaneous value (kW) and a pulsed output proportional to the energy usage (kWH). Provide Veris Model 6000 Power Transducer or approved equal.

E. Flow Sensors

1. Provide an insertion vortex flowmeter for measurement of liquid, gas or steam flows in pipe sizes above 3 inches.
2. Install the flow meter on an isolation valve to permit removal without process shutdown.
3. Sensors shall be manufactured by EMCO or approved equal.

F. Control Valves

1. Provide automatic control valves suitable for the specified controlled media (steam, water or glycol). Provide valves which mate and match the material of the connected piping. Equip control valves with the actuators of required input power type and control signal type to accurately position the flow control element and provide sufficient force to achieve required leakage specification.
2. Control valves shall meet the heating and cooling loads specified, and close off against the differential pressure conditions within the application. Valves should be sized to operate accurately and with stability from 10 to 100% of the maximum design flow.
3. Trim material shall be stainless steel for steam and high differential pressure applications.
4. Electric actuation should be provided on all terminal unit reheat applications.

G. Dampers

1. Automatic dampers, furnished by the Building Automation Contractor shall be single or multiple blade as required. Dampers are to be installed by the HVAC Contractor under the supervision of the BAS Contractor. All blank-off plates and conversions necessary to install smaller than duct size dampers are the responsibility of the Sheet Metal Contractor.
2. Damper frames are to be constructed of 13 gauge galvanized sheet steel mechanically joined with linkage concealed in the side channel to eliminate noise as friction. Compressible spring stainless steel side seals and acetal or bronze bearings shall also be provided.
3. Damper blade width shall not exceed eight inches. Seals and 3/8 inch square steel zinc plated pins are required. Blade rotation is to be parallel or opposed as shown on the schedules.
4. For high performance applications, control dampers will meet or exceed the UL Class I leakage rating.
5. Control and smoke dampers shall be Ruskin, or approved equal.
6. Provide opposed blade dampers for modulating applications and parallel blade for two position control.

H. Damper Actuators

1. Damper actuators shall be electronic, and shall be direct coupled over the shaft, without the need for connecting linkage. The actuator shall have electronic overload circuitry to prevent damage. For power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing. Non-spring return actuators shall have an external manual gear release to allow positioning of the damper when the actuator is not powered.

I. Smoke Detectors

1. Air duct smoke detectors shall be by Air Products & Controls or approved equal. The detectors shall operate at air velocities from 300 feet per minute to 4000 feet per minute.
2. The smoke detector shall utilize a photoelectric detector head.

3. The housing shall permit mechanical installation without removal of the detector cover.
4. The detectors shall be listed by Underwrites Laboratories and meet the requirements of UL 268A.

J. Airflow Measuring Stations

1. Provide a thermal anemometer using instrument grade self heated thermistor sensors with thermistor temperature sensors.
2. The flow station shall operate over a range of 0 to 5,000 feet/min with an accuracy of +/- 2% over 500 feet/min and +/- 10 ft/min for reading less than 500 feet/min.
3. The output signal shall be linear with field selectable ranges including 0-5 VDC, 0-10VDC and 4-20 mA.

PART 3 - Execution

3.1 Contractor Responsibilities

A. General

1. Installation of the building automation system shall be performed by the Contractor or a subcontractor. However, all installation shall be under the personal supervision of the Contractor. The Contractor shall certify all work as proper and complete. Under no circumstances shall the design, scheduling, coordination, programming, training, and warranty requirements for the project be delegated to a subcontractor.

B. Demolition

1. Remove controls which do not remain as part of the building automation system, all associated abandoned wiring and conduit, and all associated pneumatic tubing. The Owner will inform the Contractor of any equipment which is to be removed that will remain the property of the Owner. All other equipment which is removed will be disposed of by the Contractor.

C. Access to Site

1. Unless notified otherwise, entrance to building is restricted. No one will be permitted to enter the building unless their names have been cleared with the Owner or the Owner's Representative.

D. Code Compliance

1. All wiring shall be installed in accordance with all applicable electrical codes and will comply with equipment manufacturer's recommendations. Should any discrepancy be found between wiring specifications in Division 17 and Division 16, wiring requirements of Division 17 will prevail for work specified in Division 17.

E. Cleanup

1. At the completion of the work, all equipment pertinent to this contract shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this contract.

3.2 Wiring, Conduit, and Cable

A. All wire will be copper and meet the minimum wire size and insulation class listed below:

Wire Class	Wire Size	Isolation Class
Power	12 Gauge	600 Volt
Class One	14 Gauge Std.	600 Volt
Class Two	18 Gauge Std.	300 Volt

Class Three	18 Gauge Std.	300 Volt
Communications	Per Mfr.	Per Mfr.

- B. Power and Class One wiring may be run in the same conduit. Class Two and Three wiring and communications wiring may be run in the same conduit.
- C. Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per the National Electric Code.
- D. Where wiring is required to be installed in conduit, EMT shall be used. Conduit shall be minimum 1/2 inch galvanized EMT. Set screw fittings are acceptable for dry interior locations. Watertight compression fittings shall be used for exterior locations and interior locations subject to moisture. Provide conduit seal-off fitting where exterior conduits enter the building or between areas of high temperature/moisture differential.
- E. Flexible metallic conduit (max. 3 feet) shall be used for connections to motors, actuators, controllers, and sensors mounted on vibration producing equipment. Liquid-tight flexible conduit shall be use in exterior locations and interior locations subject to moisture.
- F. Junction boxes shall be provided at all cable splices, equipment termination, and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers.
- G. Where the space above the ceiling is a supply or return air plenum, the wiring shall be plenum rated. Teflon wiring can be run without conduit above suspended ceilings. EXCEPTION: Any wire run in suspended ceilings that is used to control outside air dampers or to connect the system to the fire management system shall be in conduit.
- H. Fiber optic cable shall include the following sizes; 50/125, 62.5/125 or 100/140.
- I. Only glass fiber is acceptable, no plastic.
- J. Fiber optic cable shall only be installed and terminated by an experienced contractor. The BAS contractor shall submit to the Engineer the name of the intended contractor of the fiber optic cable with his submittal documents.

3.3 Hardware Installation

- A. Installation Practices for Wiring
- B. All controllers are to be mounted vertically and per the manufacturer's installation documentation.
- C. The 120VAC power wiring to each Ethernet or Remote Site controller shall be a dedicated run, with a separate breaker. Each run will include a separate hot, neutral and ground wire. The ground wire will terminate at the breaker panel ground. This circuit will not feed any other circuit or device.
- D. A true earth ground must be available in the building. Do not use a corroded or galvanized pipe, or structural steel.
- E. Wires are to be attached to the building proper at regular intervals such that wiring does not droop. Wires are not to be affixed to or supported by pipes, conduit, etc.
- F. Conduit in finished areas will be concealed in ceiling cavity spaces, plenums, furred spaces and wall construction. Exception; metallic surface raceway may be used in finished areas on masonry walls. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors.
- G. Conduit, in non-finished areas where possible, will be concealed in ceiling cavity spaces, plenums, furred spaces, and wall construction. Exposed conduit will run parallel to or at right angles to the building structure.
- H. Wires are to be kept a minimum of three (3) inches from hot water, steam, or condensate piping.

- I. Where sensor wires leave the conduit system, they are to be protected by a plastic insert.
- J. Wire will not be allowed to run across telephone equipment areas.

3.4 Installation Practices for Field Devices

- A. Well-mounted sensors will include thermal conducting compound within the well to insure good heat transfer to the sensor.
- B. Actuators will be firmly mounted to give positive movement and linkage will be adjusted to give smooth continuous movement throughout 100 percent of the stroke.
- C. Relay outputs will include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.
- D. Water line mounted sensors shall be removable without shutting down the system in which they are installed.
- E. For duct static pressure sensors, the high pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low pressure port shall be left open to the plenum area at the point that the high pressure port is tapped into the ductwork.
- F. For building static pressure sensors, the high pressure port shall be inserted into the space via a metal tube. Pipe the low pressure port to the outside of the building.

3.5 Enclosures

- A. For all I/O requiring field interface devices, these devices where practical will be mounted in a field interface panel (FIP). The Contractor shall provide an enclosure which protects the device(s) from dust, moisture, conceals integral wiring and moving parts.
- B. FIPs shall contain power supplies for sensors, interface relays and contactors, and safety circuits.
- C. The FIP enclosure shall be of steel construction with baked enamel finish; NEMA 1 rated with a hinged door and keyed lock. The enclosure will be sized for twenty percent spare mounting space. All locks will be keyed identically.
- D. All wiring to and from the FIP will be to screw type terminals. Analog or communications wiring may use the FIP as a raceway without terminating. The use of wire nuts within the FIP is prohibited.
- E. All outside mounted enclosures shall meet the NEMA-4 rating.
- F. The wiring within all enclosures shall be run in plastic track. Wiring within controllers shall be wrapped and secured.

3.6 Identification

- A. Identify all control wires with labeling tape or sleeves using words, letters, or numbers that can be exactly cross-referenced with as-built drawings.
- B. All field enclosures, other than controllers, shall be identified with a Bakelite nameplate. The lettering shall be in white against a black or blue background.
- C. Junction box covers will be marked to indicate that they are a part of the BAS system.
- D. All I/O field devices (except space sensors) that are not mounted within FIP's shall be identified with name plates.
- E. All I/O field devices inside FIP's shall be labeled.

3.7 Existing Controls.

- A. Existing controls which are to be reused must each be tested and calibrated for proper operation. Existing controls which are to be reused and are found to be defective requiring replacement, will be noted to the Owner. The Owner will be responsible for all material and labor costs associated with their repair.

3.8 Control System Switch-over

- A. Demolition of the existing control system will occur after the new temperature control system is in place including new sensors and new field interface devices.
- B. Switch-over from the existing control system to the new system will be fully coordinated with the Owner. A representative of the Owner will be on site during switch-over.
- C. The Contractor shall minimize control system downtime during switch-over. Sufficient installation mechanics will be on site so that the entire switch-over can be accomplished in a reasonable time frame.

3.9 Location

- A. The location of sensors is per mechanical and architectural drawings.
- B. Space humidity or temperature sensors will be mounted away from machinery generating heat, direct light and diffuser air streams.
- C. Outdoor air sensors will be mounted on the north building face directly in the outside air. Install these sensors such that the effects of heat radiated from the building or sunlight is minimized.
- D. Field enclosures shall be located immediately adjacent to the controller panel(s) to which it is being interfaced.

3.10 Software Installation

- A. General.
 - 1. The Contractor shall provide all labor necessary to install, initialize, start-up and debug all system software as described in this section. This includes any operating system software or other third party software necessary for successful operation of the system.

3.11 Database Configuration.

- A. The Contractor will provide all labor to configure those portions of the database that are required by the points list and sequence of operation.

3.12 Color Graphic Displays.

- A. Unless otherwise directed by the owner, the Contractor will provide color graphic displays as depicted in the mechanical drawings for each system and floor plan. For each system or floor plan, the display shall contain the associated points identified in the point list and allow for setpoint changes as required by the owner.

3.13 Reports.

- A. The Contractor will configure a minimum of 4 reports for the owner. These reports shall, at a minimum, be able to provide:
 - 1. Trend comparison data
 - 2. Alarm status and prevalence information
 - 3. Energy Consumption data
 - 4. System user data

3.14 Documentation

- A. As built software documentation will include the following:
 - 1. Descriptive point lists

2. Application program listing
3. Application programs with comments.
4. Printouts of all reports.
5. Alarm list.
6. Printouts of all graphics
7. Commissioning and System Startup

3.15 Point to Point Checkout.

- A. Each I/O device (both field mounted as well as those located in FIPs) shall be inspected and verified for proper installation and functionality. A checkout sheet itemizing each device shall be filled out, dated and approved by the Project Manager for submission to the owner or owner's representative.

3.16 Controller and Workstation Checkout.

- A. A field checkout of all controllers and front end equipment (computers, printers, modems, etc.) shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the owner or owner's representative by the completion of the project.

3.17 System Acceptance Testing

- A. All application software will be verified and compared against the sequences of operation.
 1. Chiller control
 2. Boiler Control
 3. Single Zone Air Handlers
 4. Multi Zone Air Handlers
 5. Packaged Roof Top Control
 6. Cooling Only VAV
 7. Fan Powered VAV
 8. Fan Coil Control
 9. Heat Pump Control
 10. Unit Ventilator Control
- B. Control loops will be exercised by inducing a setpoint shift of at least 10% and observing whether the system successfully returns the process variable to setpoint. Record all test results and attach to the Test Results Sheet.
- C. Test each alarm in the system and validate that the system generates the appropriate alarm message, that the message appears at all prescribed destinations (workstations or printers), and that any other related actions occur as defined (i.e. graphic panels are invoked, reports are generated, etc.). Submit a Test Results Sheet to the owner.
- D. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended. Submit a Test Results Sheet to the owner.
- E. Perform an operational test of each third party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information.

End Of Section

Technical Specifications

May 2016

Item No	No of Goods/ Service	Technical Specifications and Standards
1	PV module: Photovoltaic Panel	The Panels should include the following features: • Minimum module efficiency, not less than 15% • Front cover is tempered solar glass • Frame material is Aluminum, • Exposed to a Flash Test, • Junction box is IP 65 or higher • PV panels have a max. DC system voltage of 600V or more. • PV Panels have factory-premounted DC connectors of MC4 or H4 type on min. 80 cm DC solar cable . • PV Panel manufacturer is certified according to ISO 9001 and ISO 14001. • According to IEC 61215 and IEC 61730 and TUV Safety class II certifications, certified by a reputable independent testing institute (e.g. UL, TUV, KEMA or the like). • 10-year warranty against defects from design, material or workmanship, 25-year linear power output warranty for min. 80% power output after 25 years, 90% after 10 years

2	Inverter 20 Kw	Inverter should include the following features: • Compliance with Integrated grid management functions • Suitable for outdoor mounting (IP65) • Suitable for grid connected system • Transformerless • Minimum 2 MPPT inputs per inverter • 3 Phase • LCD display with interface display • Ground fault indicator • Max. efficiency >98% / European weighted efficiency>98% • Noise emission <50db @1m • THD<3% • EN61000-6-1 and EN61000-6-3 certifications • EN50178 certification
3	Monitoring System	Remote monitoring system includes: Data logger and information storage for: • Instantaneous power • Energy produced • DC voltage and current for each MPPT • AC voltage and current Remote internet based monitoring • Values of max 15 minute intervals • Daily reports and graphs • Weekly reports and graphs • Monthly Reports and graphs • Alarm messages via email and SMS Ethernet port for communication
4	DC Cables	• Solar Type • 6mm cross section • Rating of 1000V minimum • Double insulation • UV resistant • Temperature range: -40 to 120 degrees Celsius • TUV, UL, VDE, or KEMA certification
5	AC Cables	• Appropriate cross section depending on inverter size • Double insulation • UV resistant • Temperature range: -40 to 120 degrees Celsius • TUV, UL, VDE, or KEMA certification
6	PV Module Mounting Structures	The mounting structures for the PV panels should include the following features: • The mounting structure uses concrete strip foundations, Concrete blocks must be used for weight on flat roof (No

		drilling allowed into roof floor). Minimum 75 kg per module. • The mounting system provides a fixed inclination of the modules between 20 and 30 degrees. • The mounting structure components are bonded together to guarantee potential equalization. • The mounting structure is earthed according to internationally accepted standards. • Bidder can prove that the mounting structures and the foundations thereof are structurally suitable to withstand all static loads (weight of modules, wind loads etc) that might occur according to the Site conditions. • The mounting structure uses standardized profiles and mounting clamps for mounting the selected PV modules • Structure must be made of Aluminum Alloy • No welding allowed on structure • All screws, bolts, and nuts must be made of stainless steel • Tilt angle of structure must be 22 degrees • PV modules must be facing south • Standardized profiles, fasteners, and clamps • Structure must withstand 120 km/h winds
7	Cable Protection	• All cables from PV strings to inverters, and from inverter to electrical panel must be inserted in cable protecting conduits • UV resistant • All cabling must be done using appropriate corrugated metal cable trays
8	DC Panels	• Suitable for outdoor use (IP65) • Appropriately sized DC circuit breakers according to international standards • Short circuit current protection • Overvoltage protection
9	AC Panels	• Suitable for outdoor use (IP65) • Appropriately sized AC circuit breakers according to international standards • Appropriate RCDs • Short circuit current protection
10	System Grounding	• All equipment shall be grounded in accordance with JDECO standards • Aluminum structure shall be grounded (to main grounding box) using 16 mm cross section cables • Each PV module shall be grounded (to aluminum structure) using 10 mm cross section cables • Inverters must be grounded using 16 mm cross section cables

		• All metal components including cable trays must be grounded
11	Grid Connection	• Connection to grid based on JDECO "Surplus Net Metering" • Inverters shall be connected to main consumption AC panel • Digital kWh meter shall be installed between inverters and consumption loads • Bidirectional kWh meter (from JDECO) shall be installed between consumption load and distribution grid • All grid connection costs, including kWh meters, are to be covered by the contractor
12	System Installation & Operation	- Complete system installation, commissioning, and testing in accordance with JDECO procedures, standards, rules and regulations