

SECTION 16010 - GENERAL PROVISION

The General Conditions, any supplementary General Conditions and Division 1, General Requirements, are hereby made a part of this section as fully as if herein.

PART 1 – GENERAL

1.1 Scope of Work:

- A. Note: - This work is subject to applicable mechanical sections where there is specified equipment with electrical connections. All work in other parts of Division 16 shall meet requirements of this section.
- B. This work includes all labor, materials, equipment and services for a complete electrical system. Included in this contract, but not limited to, is the following:
 - 1. Coordination of connections and providing conduits for all work required for the complete installation of electrical service.
 - 2. Electrical equipment and building grounding systems.
 - 3. Furnish and install electrical connections complete to all equipment.
 - 4. Coordinate connection of mechanical and heating and cooling equipment with furnishing trade. Furnish and install motor starters and disconnects as required by National Electrical Code. Do all power wiring from panel to disconnect to starter and to motor or equipment. Wire all line voltage controls carrying motor or equipment power. Interconnecting low voltage or control wiring shall be done under section specifying the equipment.
 - 5. Support systems for electrical work.
 - 6. Cutting and patching for installation of work specified under Division 16.
 - 7. Temporary service during construction.
 - 8. Test of electrical systems.
 - 9. Demolition of electrical, see demolition drawings for notes.
 - 10. All site work required for electrical equipment, which includes but is not limited to, service entrance.
 - 11. Facility communication system and all interconnecting wiring and conduits.
 - 12. Fire alarm system. Provide a manual toggle switch located at the main entrance which shall shut down all HVAC systems.

- C. Under this section provide electric services for all fixtures, appliances and items of equipment requiring same and shown on any contract drawings, specified under this division, mechanical division or any other division or specifications, or specified to be furnished by Owner.
- D. Electrical contractor is strongly urged to examine the premises and observe the existing conditions under which site work will be done and all other circumstances which will affect work before submitting bid. The submittal of a bid will indicate that the contractor has made a site visit and has full knowledge of the existing conditions and any problems which may occur in the completion and performance of the work.

1.2 Local Conditions:

- A. Examine the premises and observe the conditions under which work will be done and all other circumstances which will affect the work before submitting bid. The submittal of a bid will indicate that the Contractor has full knowledge of the problems involved in the performance of the work.
- B. Verify, in the field, scale dimensions on plans.
- C. Check architectural, structural, mechanical, and electrical plans to avert possible installation conflicts.
- D. Prior to installation of materials and equipment, discrepancies between plans and actual field conditions or between plans and specifications shall promptly be brought to the attention of the Architect/Engineer for a decision.

1.3 Applicable Codes and Standards:

- A. Unless stated otherwise in the GENERAL CONDITIONS, the currently adopted codes by the enforcing authorities shall govern.
 - 1. NFPA Codes.
 - 2. IBC Building Code.
 - 3. Local codes.
 - 4. Requirements of the Fire Marshal.
 - 5. ADA.
 - 6. Maryland Building Code for the Handicapped.
 - 7. ANSI A117.1 - 2004.

1.4 Listed Equipment:

- A. All electrical equipment and cables shall be labeled or listed by a nationally recognized listing or testing agency. The equipment shall be installed only in applications for which it is listed and as per the listing requirements. Should this specification inadvertently indicate a manufacturer whose equipment is not listed or labeled, the contractor shall notify the Engineer for direction. Under no instance shall the non-listed equipment be installed.

1.5 Energy Star Compliance:

- A. All light fixtures used on this project shall be in compliance with the State of Maryland "Energy Star" program.

1.6 Submittals:

- A. All submittals shall include sufficient data to make a thorough evaluation of features, construction and performance. Submittals shall be bound in booklet form with a cover sheet indicating each item and respective manufacturer's catalog number.
- B. Materials, equipment and fixtures shall completely satisfy specification requirements and be suitable for their intended use. Items or equipment submitted shall include all accessories and options recommended by the manufacturer for satisfactory, reliable and safe operation in its designated location.
- C. Where model number or name of one manufacturer is followed in specifications by one or more other manufacturer's names, design has been based on first product named and shall be considered to be the specified product or manufacturer, named alternates may require minor deviations. Contractor shall indicate deviations in submittals/shop drawings.
- D. Under base bid, furnish equipment and material specified or named alternates. Products submitted shall be equal in quality to products of the specified manufacturer and shall include the standard features of the specified product and also optional features or necessary changes specified herein. Submittal of alternates shall include all changes in building systems, piping, wiring, supports or accessories required for satisfactory and intended operation. Engineer shall be final judge of equivalence.
- E. Substitute equipment submitted shall include a price change or advantage to Owner, if accepted, at time of submission. Product and performance requirements of substitute items shall be the same as named alternates.
- F. Contractor shall insure that material and equipment delivered to job site is suitable for the intended application and indicated connections. Review of shop drawings shall not include review of specified quantities.
- G. Review of and noted comments on Contractor's submitted shop drawings do not constitute a change order or a waiver of contract requirements. In the event of conflict between submittals or shop drawings and contract documents, the latter

shall govern. If waiver of particular requirement is requested by Contractor a formal written request shall be made to Owner as per General Conditions.

- H. When directed, Contractor shall provide samples of material or equipment, as directed.
- I. Equipment shall be shipped or fabricated in sections in suitable size for entering building and all necessary arrangements for their installation shall be made by Contractor.
- J. Shop drawings and submittals shall bear the General Contractor's review and approval stamp prior to submission to the Architect.
- K. Submittals shall be bound in booklet form, include a summary cover page listing manufacturer and model number and shall indicate if the submitted item is a substitute. Furnish a minimum of six (6) copies of all submittals or as required by the Architect. At least one submission shall be a manufacturer's original product and data sheet, the remaining may be photocopies. Three (3) copies of all shop drawings and material cuts are required for equipment brochure at contract completion.
- L. Within 30 days after award of contract, submit a complete list of materials to be used on project specifying manufacturer, grade, trade name, and catalog number. Materials list shall be complete. Partial list not acceptable.
- M. Submit copies of shop drawings for all electrical equipment custom-made for this contract. Drawings shall be revised as directed and resubmitted.
- N. Manufacturer's drawings, sketches, and instructions shall supplement but not supersede contract drawings and specifications.
- O. Submittals shall show:
 - 1. Physical size and arrangement of equipment.
 - 2. Wiring diagrams for all equipment showing all circuit devices, conductor sizes, color coding, type, etc.
 - 3. Elementary control diagrams in straight line form for motor control equipment showing all control devices connected in the system.
 - 4. Specifications for all components.

1.7 Cutting and Patching:

- A. Refer to the General Conditions for cutting and patching. Patch all existing walls which were cut for installation of electrical equipment and wiring. Patch all openings where existing electrical devices are removed.

- B. Neither cutting of structural members, nor the drilling of holes through beams or structural steel shall be done without the specific permission of the Architect or Engineer.

1.8 Fire Seals:

- A. Provide fire rated seals for all penetrations through fire rated floors or walls. Fire seals shall be provided in a manner to maintain the integrity of the fire wall. Where conduits penetrate floor which do not extend more than 5' from the wall, provide an "expanding" type grout around conduit. Provide UL listed fire sealant inside conduit, Dow Corning silicon foam or approved equal. PVC conduit shall have a UL listed expanding fire barrier. See Section 16110 for additional requirements.
- B. Junction Boxes - Provide putty wraps on all junction boxes in fire rated walls.

1.9 Materials and Accessories:

- A. Materials shall be new and listed by the Underwriters Laboratories, Inc., or locally approved national testing agency as conforming to standards in every case where such a standard has been established for the particular materials in question.
- B. Contractor shall field verify fit of equipment in available space prior to rough-in. Any discrepancies shall be brought to the attention of the Architect/Engineer.
- C. Equipment shall be packaged in their original containers and be limited to products regularly produced and recommended for service ratings in accordance with manufacturers' catalogs, engineering data or other comprehensive literature made available to the public, and in effect at the time of contract award and shall be turned over to the Owner free of all defects.
- D. All equipment or materials for any one system shall be furnished by the same manufacturer. Such items as lamps, conduit fittings, wire, electrical switchgear, wiring devices, etc., shall be the same throughout the project.
- E. Materials installed on exterior of buildings shall be weather tight and of such design as intended for this purpose. Ferrous exterior materials, galvanized.
- F. Equipment shall be installed in strict accordance with manufacturer's instructions for type, capacity and suitability of each piece of equipment used. Use weatherproof equipment where required. Install equipment in accordance with manufacturer's recommendations and meet conditions for manufacturer's standard warranty.
- G. Contractor shall effectively protect his work, materials, or equipment which is liable to injury during construction period. Openings into any part of conduit system as well as associated fixtures, equipment, both before and after being set in place must be securely covered or otherwise protected to prevent obstruction of

conduit or injury due to carelessness or maliciously dropped tools or material, grit, dirt, or any foreign matter. Contractor is responsible for all damage so done until his work is installed and accepted. Conduit ends shall be covered with capped bushings.

- H. Provide all accessories, equipment and connections required for complete installation, ready for continuous use by Owner.

1.10 Inspection and Regulations:

- A. Do not allow or cause any of this work to be covered up or enclosed until it has been inspected, tested and approved by the authorities having jurisdiction over the work. Should any of this Contractor's work be enclosed or covered before such an inspection and test, he shall, at his own expense, uncover the work and after it has been inspected, tested and approved make all repairs with such material as may be necessary to restore all of his work and that of the other contractors to its original condition.
- B. Work shall meet requirements of Owner, National Electrical Code, local regulations, and rules of the Utility Company. Equipment and materials shall bear label of approval of National Board of Fire Underwriters and be U. L. listed for their particular application.
- C. Work shall meet requirements of the owner's insurer.

1.11 Tests:

- A. Give timely notice of intention to test or cover up work to permit observation. Contractor shall test all wiring for continuity and grounds before connecting any equipment or outlets. Contractor shall test entire system in accordance with current procedures stated in Acceptance Testing Specifications published by the InterNational Electric Testing Association, Inc.(NETA). All equipment necessary to conduct such test shall be furnished at the Contractor's expense.

1.12 Work by Others:

- A. Following work is by others or is specified under other Divisions of this specification:
 - 1. All automatic temperature control system wiring and equipment shall be furnished and installed under Division 15, unless specifically noted otherwise.
 - 2. Power Company charges for electrical service installation shall be paid by the owner.

1.13 Cooperation with Other Trades:

- A. Confer with all other trades whose work might affect installation and arrange

work in proper relation to that of others and with architectural finishes.

- B. Where interferences occur, Contractor shall, before installing work involved, consult with Architect and other trades to reach agreement as to exact location and level of work.
- C. Contractor is responsible for arrangement of work, equipment and maintenance of proper clearances for installation. Should work installed require modification to avoid interference, such changes shall be made without additional cost.
- D. If work is dependent for its proper execution on contiguous work not specified in this Division. The Contractor shall examine such work and report in writing any defects therein or conditions rendering it unsuitable. Beginning of work without making of such a report shall constitute an acceptance of such work, and any subsequent defects in his work consequent shall be of his responsibility.

1.14 Field Measurements:

- A. Visit the site before submitting bid and check location of existing utilities, conditions, verify dimensions and locations shown on the plans and overall costs and work herein described or shown.
- B. Take measurements necessary for this work and be responsible for their accuracy. Necessary pull boxes and junction boxes as required to accomplish distribution shall be provided.

1.15 Structural Difficulties:

- A. Should structural difficulties prevent performing work, necessary deviations, as determined by Architect, shall be performed.

1.16 Access Panel:

- A. Provide access doors or panels for concealed portions of the work requiring accessibility for operation and maintenance. Minimum door size is 12" x 12". Door to be same fire rating as system in which they are installed. See architectural specifications for finish and manufacturer.

1.17 Drawings and Specifications:

- A. Drawings shall be considered schematic in nature and shall represent a completed product. Contractor is responsible for installation of equipment and methods of achieving a satisfactory and intended installation. Locations of devices are intended to show a general arrangement and intended function. Door swings and architectural features shall be checked for final condition. Coordinate with all contract documents, Owner provided furniture or equipment drawings, structural, architectural, and mechanical plans and specifications. Coordinate with other trades.

- B. Where a conflict exists between drawings and specifications, the Architect/Engineer shall be contacted to determine the intent. In all circumstances, the final contract document interpretation shall provide compliance with all codes.
- C. Wiring devices shall be located uniformly with respect to building structure and other work. Locations shall be coordinated. Should there be any interference between electrical wiring and other trades, Contractor shall notify Architect so that proper location may be decided upon.

1.18 Permits:

- A. All permits, licenses or incidental fees not otherwise identified under provisions of General Conditions of this contract specification shall be borne by this Contractor. This shall include electrical and fire alarm permits.

1.19 Operations and Maintenance Manuals:

- A. Furnish 3 sets of Operation Manuals in loose leaf binders. The manuals shall include:
 - 1. Descriptive brochures on all equipment.
 - 2. Maintenance instructions.
 - 3. Operation Instructions.
 - 4. Parts list for all equipment.
 - 5. Certificates for equipment as required.
 - 6. Service phone number of installing company.
 - 7. Table of Content.
 - 8. Wiring Diagrams.

1.20 “As Built” Drawings:

- A. A separate set of white background Electrical prints marked in red ink “As Built” shall be kept in good condition at the job site during progress of construction. Mark to indicate changes as they occur in the field installation of equipment.
- B. Show location of equipment, conduits, etc.
- C. At all times, these Drawings shall be up-to-date and available at the site for verification. Before final payment is approved, the Drawings shall be made correct and delivered to the Architect. The correct circuit breaker numbers shall be used on the “As-Builts”.

- D. At the completion of the job, the contractor shall obtain the AutoCAD drawing files from the Engineer at cost and update file from the “as-built” drawings. The updated AutoCAD files and plotted drawings shall also be delivered to the Architect.

1.21 “AutoCAD Files :

- A. The contractor may obtain the AutoCAD drawing files from the Engineer at a cost of \$50 to assist in the preparation of shop drawings and/or as-built drawings for this job. No materials or information from the AutoCAD files shall be duplicated or used for any other project.

1.22 Guarantee:

- A. Unless otherwise specified, guarantee unconditionally for a guarantee period as set forth in General Conditions all materials, workmanship and installation. During this period, adjust, repair or replace at no cost to Owner any item of equipment or workmanship found to be defective.
 - 1. Contractor shall be responsible for and pay for damages caused by or resulting from defects in workmanship.

(END OF SECTION)

SECTION 16100 - BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 Scope of Work:

- A. Requirements of this section apply to all other parts of Division 16.

PART 2 - PRODUCT

2.1 Raceways and fittings, minimum size 3/4 inch, except for controls, which may be 1/2 inch. A separate insulated grounding conductor shall be provided in all conduits and raceways.

- A. EMT - Electrical Metallic tubing: Triangle PWC, Republic, or Porter, galvanized steel, enameled inside finish, UL-797, WW-C-563.
- B. IMC - Intermediate Metal Conduit: Triangle PWC, Republic or Poreter, galvanized mild steel, enameled inside finish, UL-1242.
- C. Galvanized rigid steel conduit: Triangle PWC, Republic or Porter, hot dipped galvanized steel, UL-6, WW-C-582D.
- D. Flexible metallic conduit: Triangle PWC, Republic, or Porter, Greenfield, electro-galvanized steel, WW-C-566B, UL-1.
- E. Non-metallic conduit: Olin, Triangle, Porter, Carlon, Schedule 40 or Schedule 80 polyvinyl chloride (PVC) conduit.
- F. Liquid-tight flexible conduit: Sealtite, American Brass type U.A.

2.2 Conduit Fittings:

- A. Compression fittings, Steel: Midwest, O-Z Gedney, Steel City.
- B. Set screw fittings, steel: Midwest, O-Z Gedney, Steel City.
- C. Plastic insulating bushings: T & B, O-Z, Gedney, Scotch, Steel City, Racor, Appleton, Efcor, Union.
- D. Metallic bushings: T & B, Gedney, Steel City, Racor, Appleton, Efcor. Use metallic bushings where bushing is exposed.
- E. Flexible liquid resistant conduit fittings: Sealtite or equal.
- F. Expansion Joints:
 - 1. Conduits, rigidly secured to building construction on opposite sides of a building expansion joint, shall be provided with expansion and deflection couplings. The couplings shall be installed in accordance with the

manufacturer's recommendations.

2. Expansion and deflection couplings shall also be installed where shown on the drawings.
3. The expansion/deflection couplings shall be by O-Z/Gedney or equal.

2.3 Ground System Devices and Equipment:

- A. Ground rods -- 3/4" x 10' copperweld.
- B. Ground rod and cable connections underground: Exothermic weld such as Cadwelded or Thermowelded.
- C. Cable connections accessible: Brundy, Hy-press type.
- D. Ground bushings: O.Z. Type BL.
- E. Pipe connectors: O.Z. Type ABG.
- F. Enclosure connector: O.Z. Type QG or KG.
- G. Feed through lug: Brundy type Q2B.

2.4 Boxes:

- A. Outlet, junction, switch, or manufactured pull boxes shall be one piece stamped galvanized steel, machine screw fasteners with ground bond screw, UL listed.
- B. Conduit fittings shall be steel. Conduit fittings shall be by Appleton or approved equal.
- C. Cast boxes, types FS and/or FD shall be of malleable iron or aluminum. Cast boxes of Feraloy ("gray metal") shall not be acceptable. Cast boxes shall be Appleton or approved equal.
- D. Group surface mounted device boxes shall be in a multi-gang cast box. The size shall be governed by the intended use.
- E. Exposed boxes less than eight feet above floor or on accessible finished surfaces shall not have removed and unused knockouts. Boxes with exposed knock-outs will not be accepted. Use cover plates which do not protrude beyond the box and without sharp edges. Box mounting hardware shall be concealed within the box. Boxes shall be fastened to studs where spacing permits.
- F. Exterior wall surfaces or otherwise exposed to weather shall be cast FD boxes with threaded hubs and neoprene gaskets. U.L. Listed.
- G. Stamped outlet boxes: one piece galvanized steel. Boxes shall not be smaller

than 4" octagon or square and shall have machine screw fasteners and bond screws. U.L. Listed. Outlet boxes shall be Steel City, Raco, Bowers or Appleton.

- H. Pull boxes: construct of code gauge galvanized sheet steel with screw cover. UL Listed.

2.5 Power Poles:

- A. Power poles shall be 3" square, steel housing separate telecommunications and power compartment. Each pole shall have duplex receptacles, power connections and plate for voice/data. Power poles shall be fastened at the floor with a factory furnished baseplate, ceiling trim flange, and pole top junction box. Provide Wiremold 3 DTP series with accessories required for complete and functioning installation. Length shall be between 10'-5" and 15'-5" as required by ceiling height.

2.6 Conductors:

A. General:

1. Unless specifically indicated otherwise, all wiring shall be 98 percent conductivity copper conductors. Minimum wire size shall be #12 AWG. All wire AWG #8 or larger shall be stranded. Insulation shall be dual rated THWN/THHN. Manufacturers shall be Triangle, Phelps Dodge, or Royal.
2. Where aluminum wire is specified for feeders, wire shall be compact stranded Stabiloy, by Alcon Cable Corp. Insulation shall be XHHW 90 degrees C. All terminations shall be tool applied compression connectors, as specified below, for all wire ends including circuit breaker, disconnects, and terminal block connections. At contractors option he may use copper conductors with equivalent capacity.

B. Wire Within Buildings:

1. Single conductor wires: 600 volt, dual rated THWN/THHN, within metallic raceways. Two wire drops to light fixtures may be flexible metallic conduit in lengths not over 6 feet, as permitted by code.
2. Cable Assemblies -600 Volt:
 - a. Type MC cable shall be temperature rated as required by location and installation. Cable shall have a continuous insulated ground wire and be bonded to device and box screw. Provide proper color coding for system voltage.

C. Exterior Wiring:

1. Service Entrance: Dual rated THWN/THHN..

2. Underground: In conduit: dual rated THWN/THHN.
3. Above grade: In conduit: Type dual rated THWN/THHN.
4. Aluminum wiring shall not be used.

D. Wire Connectors:

1. Copper wire: For connections of one or more #10 AWG or smaller, solderless twist-on connectors shall be used. The connectors shall have an outer insulating shell manufactured from nylon (polyamide) material and shall be formed with "S"-shaped fins to improve the twisting action. The spring insert shall be a helical elongated coil formed from square spring steel to cause the spring to have "live action" and reduce the turning friction. The connectors shall be rated flame and heat retardant for up to 105 degrees C maximum and be Underwriter's Listed under UL 486. Connectors shall be Buchanan "B"-Caps or approved equal by Pass & Seymour, Ideal, Hycos. Conductors #8 AWG and larger shall be terminated, spliced or tapped wherever practicable with T & B "Color Keyed" Series 54000, tool applied compression connectors or approved equal.
2. Aluminum wire: Where aluminum connectors are spliced, tapped or terminated, including connections to panelboards, circuit breakers and equipment, connectors shall be tool applied Burndy Types AYP, AYPO, YA-A Series 54000 compression connectors, or approved equal, with wire barrels factory pre-filled with an oxide inhibiting compound. Terminating pigtails shall be T & B or MAC with insulating sleeves or approved equal.
 - a. Terminations: Belleville type compression washers shall be used when ambient temperature exceeds 30 degrees. C, T & B Series 60800 or approved equal.
 - b. Compression tools: All compression connectors shall be made with manufacturer's recommended tool incorporating a ratchet release type mechanism to insure complete compression, typically Burndy Y-39 Hypress or approved equal.

E. Wire Fastening Products:

1. Provide wire fastening products when wiring is specified or required to be secured.
2. Wire fastening products shall include but not be limited to the following types of components: natural nylon cable ties, black (UV-resistant) cable ties, cable tie mounts, adhesive cable tie mounting pads, adhesive press clips, molded nylon clamps, molded polypropylene clamps, flat nylon clamps and adhesive-mount adjustable clamps.

3. The contractor shall provide all accessories required for a complete and satisfactory installation.
 4. Wire fastening products shall be by Brady or approved equal.
- F. Wire Pulling Lubricants:
1. Use pulling lubricants on all raceway wiring. Pulling lubricants shall be of a greaseless compound, non-corrosive, non-conductive, non-combustible, non-toxic, for use with PVC, steel, aluminum or copper raceways and safe for use on all UL-listed wire insulation. The pulling lubricant shall be "Quick-Slip" by Buchanan or approved equal by Ideal.
- G. Electrical Supporting Devices:
1. Materials secured to the structure by: inserts cast in concrete, expansion anchors in concrete block, machine screws or bolts on metal surfaces. Bolts and screws used on interior shall be black steel or galvanized; on exterior, brass or bronze. Cartridge driven studs used only where specifically noted or permitted by the Architect. Hangers shall be as follows:
 - a. Steel channel: Kindorf, Unistrut, Globe Strut, Strut by 'B-Line'.
 - b. Channel fittings: Kindorf, Unistrut, Globe Strut, fittings by 'B-Line'.
 - c. Conduit hangers: Clevis type by Unistrut, Kindorf, Grinnell.
 - d. Wall anchors: Expansion bolt, toggle bolt, or other approved structural anchor. Plastic anchors, wood or fiber plugs shall not be used.
 2. All electrical materials and conduits larger than 2" shall be secured to joists shall be fastened to the top member of the joist.

PART 3 - EXECUTION

3.1 Preparation:

- A. Check door swings and clearances with equipment, cabinets, appliances and coordinate with all contract drawings prior to performing work.

3.2 Installation:

- A. Switches and receptacles shall be installed in locations shown on contract drawings. Contractor shall study general building plans in relation to space surrounding each device in order that intended work may accommodate all other

specified work. Boxes shall be installed in a rigid and satisfactory manner. Support all boxes independent of raceways. Adjacent wall mounted wiring devices, room thermostats or other equipment shall be coordinated and so located either at the same elevation or in line, one above the other. Install conduit, outlets and equipment to clear beams or obstructions. Do not cut into or reduce the size of any load-carrying member without the approval of the Architect. Permission of resident Architect shall be obtained before cutting any existing structural concrete walls or floors. Check drawings and work of others to prevent interference. Deviations of work to avoid obstructions as determined by the Architect shall be done without additional cost.

- B. Wiring and conduit shall be kept at least 6 inches from parallel runs of heated pipes or ducts. Exposed runs of conduit or tubing shall have supports spaced not more than 6 feet apart and shall be installed with runs parallel or perpendicular to walls, structural members or intersections or vertical planes and ceilings, with right angle turns consisting of cast metal fittings and symmetrical bends.
- C. Exposed wiring and conduit shall be installed in a neat and workmanlike manner with runs plumb and parallel to walls. Bends and offsets shall be avoided where possible, but where necessary shall be made with an approved hickey or conduit bending machine. Conduit or tubing which has been crushed or deformed in any way or has begun to rust shall not be installed. Use expansion bolts to secure equipment, conduit or devices. Wood or dowel plugs are not acceptable. Conduits or tubing shall be supported on approved types of galvanized wall brackets, ceiling trapeze or pipe straps, secured by means of expansion bolts in concrete or brick. Nails shall not be used as a means of fastening surface boxes or conduits. Conduit or tubing shall be installed in such a manner as to insure against trouble from collection of trapped condensation and all runs on conduit shall be arranged as to be devoid of traps wherever possible.
- D. Raceways and cable shall meet requirements of the National Electrical Code and local codes.
- E. General branch circuit wiring shall be concealed in walls and above ceilings. Do not run branch circuit wiring below slab except where indicated by dashed lines or for floor devices.
- F. Except noted or specified otherwise, wiring shall be installed as follows:
 - 1. Indoors in finished areas, conceal in walls or above ceilings: EMT or MC cable.
 - 2. Indoors, exposed in existing finished areas with drywall or plaster walls and ceilings: Cut and patch to install MC cable or EMT.
 - 3. Indoors, exposed in newly finished areas: Not acceptable, conceal wiring.
 - 4. Indoors exposed in unfinished areas: EMT. (No exposed MC cable will be accepted).

5. Outdoors, exposed: threaded, painted IMC.
 6. Outdoors underground: PVC schedule 40 (3/4" min), unless noted otherwise.
 7. Liquid-tight flexible metal conduit shall be used for connections to motors and other electrical equipment subject to movement, vibration, mis-alignment, cramped quarters or noise transmission.
- G. Clamps shall be malleable iron. Multiple runs shall be supported on metal channel with conduit clamps. Trapezes shall be metal channel with conduit clamps.
- H. Check door swings and clearances with equipment, cabinets, appliances and coordinate with all contract drawings prior to performing work
- I. Conceal all raceways and wiring in finished areas. Finished areas shall be defined as those areas having finished or painted walls. All wiring in mechanical and electrical rooms may be exposed and shall be in EMT. No exposed MC cable will be accepted.
- J. Penetrations through concrete walls, floors and footings., both interior and exterior shall be sleeved and caulked with grout or plastic compound to provide watertight seal.
- K. Seal conduits exposed to weather or subject to low temperatures to prevent air infiltration.
- L. Penetrations through roof shall be flashed with galvanized sheet metal roof jack. Jack shall fit tightly at top of cone and the skirt shall extend not less than 6" beyond the base of the cone. Seal opening between conduit and top of cone with caulking compound. Exposed conduit on roof: IMC. All work on roof shall comply with roof warranty and roofing specifications.
- M. Handling and installation: Bends shall be kept in accordance with minimum recommended by manufacturer. Cables shall be paralleled on reels and be pulled directly into raceway from the coil or reels on which they are received. Cable shall not be laid on the ground.
- N. Use pulling lubricants on all raceway wiring. Wire and cable installed only after raceways are free of obstructions and clean. All wire color coded. Wiring shall be tagged with Brady "Quick" labels at all pull boxes, junction boxes and panelboards. Wiring in panelboards and terminal cabinets shall be neatly trained and served.
- O. Where new wiring is indicated at existing walls, conceal as much as possible. Cut and patch existing drywall and plaster walls to conceal wiring.
- P. Fire seals shall be used to maintain the integrity of fire rated walls, floors,

partitions, or ceilings.

- Q. Conductors at vertical raceways shall be supported. One support shall be provided at the top of the vertical raceway, refer to NEC 300-19 for spacing criteria.

3.3 Demolition:

- A. Remove all light fixtures, wiring devices, telephone outlets, and indicated items noted on the demolition plans.
- B. Where removal of a wiring device or light fixture will disconnect power to downstream electrical items, contractor shall provide required junction boxes, conduit, and wiring to keep "existing to remain" items fully operable.
- C. The owner shall have first claim on any removed materials. If the owner does not want demolished materials, the contractor shall dispose of the materials appropriately.
- D. All Hazardous electrical materials such as PCB ballasts and fluorescent lamps shall be disposed of in an EPA approved manor.

3.4 Guarantee:

- A. Unless otherwise specified, guarantee unconditionally for a guarantee period as set forth in the General Conditions all materials, equipment, workmanship and installation. During this period, adjust, repair or replace at no cost to Owner any item of equipment or workmanship found to be defective.

(END OF SECTION)

SECTION 16300 – SOLAR PHOTOVOLTAIC ENERGY SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. System Description:

1. The Photovoltaic (PV) energy system consists of 99 PV modules mounted on a rooftop ballasted racking system, designed as nine strings wired to (1) 9kW and (1) 11kW inverter and interconnected through a tap to the electrical system's Main Distribution Panel. This system is a grid-connected Solar PV Energy System with the capacity of 24.75 kW DC (@ STC).

1.2 GENERAL JOBSITE REQUIREMENTS

- A. Contractors are required to maintain a clean work area by minimizing debris and the unnecessary accumulation of litter.
- B. Contractors are responsible for removing all tools, equipment, unused materials, and garbage from the job site premises at the time of system commissioning.
- C. Contractor to follow all Authority Having Jurisdiction (AHJ) rules and regulations and Occupational Safety and Health Administration (OSHA) guidelines for creating and maintaining a safe workplace environment throughout the construction of the Solar PV Energy System.
- D. Contractor to develop and implement an approved jobsite safety plan that conforms to OSHA guidelines.
- E. Provide all roof membrane protection for the roof during construction to the highest degree of care possible to prevent damage, penetration and wear in compliance with attached roof warranty and industry standard practices.
- F. Construction of electrical equipment structures as needed to support the string combiner boxes, disconnects, and conduit. Provide and install all grounding components/systems as shown on the contract drawings and required by the module, racking system, combiner box and inverter manufacturer.
- G. Roof penetrations, if needed, will be provided by the Contractor and installed by a qualified roof Contractor.

1.3 WORK INCLUDED BY OTHERS

- A. The Contractor has subcontracted with the Electrical Contractor for the installation of the Combiner Boxes, conduit and wiring of the output circuits, installation of the inverter and all interconnection and DAS equipment and the start up and commissioning of the entire Solar PV Energy System.

1.4 WORK INCLUDED

- A. PV Array Contractor will provide the necessary crane, lift or methods of transport to the roof for all equipment provided by the Contractor, required by the Electrical Contractor and materials supplied by the PV Array Contractor.
- B. PV Array Contractor will provide the necessary OSHA safety barriers on the roof.
- C. PV Array Contractor to install per the drawings and specifications the Material Provided by Contractor including the PV racking system, inverters, AC panels, AC disconnects, ballast / slip sheets, mid-span supports, rails, end/mid clamps, all DC source circuit raceways, wire, MC Connectors, ground lugs, and devices to connect to the 2 combiner boxes, and the termination and testing of the 9 strings.

1.5 GENERAL CONTRACT REQUIREMENTS

- A. All Commercial Terms, Conditions, and Requirements as established by the contract with the Contractor.
- B. All requirements outlined in this specification.
- C. The requirements are shown in the Site, Architectural and Electrical drawings provided with this specification.

1.6 SUBMITTALS FOR REVIEW

- A. Project Schedule
 - 1. Submit a modified schedule if different than the Contractors proposed Appendix 4 - Project Schedule in the contract with the Contractor.
- B. Project Team including experience and training credentials for the following as needed and appropriate for the work included:
 - 1. Project Manager
 - 2. Job Foreman
 - 3. PV System Installer(s)
 - 4. Licensed Electrician
 - 5. NABCEP Solar PV Installer
 - 6. Certified Roofing Contractor (if applicable)
 - 7. Heavy Construction Equipment Operators with certifications
- C. Product Data:
 - 1. Provide the manufacturers product data selected
- D. Testing, Commissioning and Final Inspection Plan
 - 1. Coordination with the Electrical Contractor to install, test and correct as needed the system per the standard Solar PV System Electrical Installation and Test Procedure.

1.7 RECORD AND RECORD DRAWINGS

- A. As the work progresses, the Contractor will record on one set of plans and specifications all changes, deviations, or alterations made to the original design. At the final inspection, the Contractor will turn in the record set of drawings and specifications over to the Contractor.

1.8 OPERATION AND MAINTENANCE MANUAL

- A. Deliver to the Contractor all the Manufacturer's product information and Warranty documentation received or attached to any and all equipment purchase or provided including the specific Model Number and Serial Number for each component (where applicable)
 - a. Ballasted Racking System
 - b. PV Modules
 - c. Combiner boxes
 - d. Disconnects
 - e. Inverters
 - f. Panels
 - g. Circuit Breakers
 - h. Fuses
 - i. Meters
- B. Coordinate with the Electrical Contractor the production of the completed and signed Commissioning and Inspection Record
- C. Provide and assist in providing all information and assistance with applications as required to apply for extended warranty.

1.9 WARRANTY

- A. Submit Contractor's warranty and ensure that forms have been completed in the Contractor name and registered with the Manufacturer. The Contractor shall provide the following warranties to Contractor :
 - 1. A full parts and labor warranty for the Work Included for the period listed in the contract from the date of installation. The parts and labor warranty is to cover any and all labor and workmanship provided by the Contractor. The warranty shall provide for parts, labor and incidental repair costs such as shipping. The warranty is not required to cover problems resulting from exposure to fire, flood, hurricane, tornado, earthquake, lightning or other Acts of God, vandalism or alteration of the system by anyone not authorized by the installation company.
 - 2. The above language shall be included in the Contractor's warranty to Contractor.

1.10 QUALITY ASSURANCE

- A. Contractor Qualifications:

1. Contractor must have or obtain all applicable licenses and certifications required, in order to perform the work outlined in this scope; based on national, state, and local codes and ordinances prior to installation.
 2. All electrical interconnections, to be performed by a licensed Master Electrician, experienced and trained with PV installations.
- B. Changes to the plans and specifications shall be submitted and approved by Contractor
- C. After the solar PV energy system is installed, the Contractor shall assist the Electrical Contractor test and commission the system to assure its functioning properly.
- D. The installed solar PV system shall pass all Design Professional submittal, preliminary and final inspections.

1.11 REGULATORY AND CODE REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. (or equivalent) and Institute of Electrical and Electronic Engineers, as suitable for the purpose specified and indicated. (e.g., UL 1703, Class C fire rating; and UL 1741, IEEE 929-2000 / IEEE 1547).
- B. Installation shall conform to the National Electric Code (NEC) 2011 - or most recently approved version by the AHJ. Specific requirements for PV installations are established in Articles 690 and 705.

1.12 APPROVAL AND ACCEPTANCE

- A. The system shall be installed, approved and accepted per the Contract, the requirements of the plans and specifications, the manufacturer's Installation Manuals and recommendations, the Authority Having Jurisdiction (AHJ), utility and any agencies or departments providing grants or incentives.

PART 2 - PRODUCTS OVERVIEW

2.1 GENERAL

- A. Products to be provided by Contractor are identified in this specification

2.2 MODULES

- A. Manufacturer / Model
1. Hanwha HSL 60 Cell 250W

2.3 INVERTERS

- A. Manufacturer / Model

1. SMA SB9000-US TL
2. SMA SB11000-US TL

2.4 DC COMBINER BOXES

A. Manufacturer / Model

1. SMA SB TL Combiner

2.5 MONITORING

A. Manufacturer / Model

1. SMA Sunny Webbox, or approved equivalent

2.6 BALLASTED ROOF MOUNTED PHOTOVOLTAIC RACKING SYSTEM

A. Manufacturer / Model

1. TBD

2.7 BALLAST / MID RAIL SUPPORT

A. Manufacturers / Model

1. Manufacturer provided or approved equivalent based on Manufacturer specifications

2.8 BALLAST SLIP SHEET

A. Slip Sheet - 60 MIL EPDM

2.9 EPDM ROOF SEALANT

A. Manufacturer / Model

1. Chem Link M-1 Sealant or Approved Equal

2.10 GROUND BONDING CONNECTOR

A. Manufacturer / Model

1. Wiley Electronics / WEEB PMC

2.11 GROUNDING LUG

A. Manufacturer / Model

1. Burndy WEEB-LUG or Approved Equivalent

2.12 STAINLESS STEEL CABLE CLIPS FOR AWG 10 PV OR USE-2 WIRE

A. Manufacturers / Model

1. Wiley Electronics or Equivalent
 - a. AWG 10 PV cable - Acme Cable Clip / Part # ACC-PV
 - b. AWG USE-2 cables - Acme Cable Clip / Part # ACC

2.13 POWER WIRE

- A. All PV power conductors in free air shall be copper **USE-2 or PV**.
- B. All conductors in conduit shall be THWN-2 or XLLP minimum 90°C rated and labeled according to NEC 2011 or most recently approved version by the AHJ.

2.14 RACEWAY

A. Manufacturer / Model

1. 2" x 2" Standard Hot dipped galvanized steel or approved equivalent

2.15 WIRE TIES

A. Manufacturer / Model

1. Panduit or equivalent Nylon 12 with 12-15 Years Weathering Life Expectancy /UV Resistance
 - a. 7.4" PLT2S-M120
 - b. 14.5" PLT4H-TL120

2.16 SOLAR PRODUCTION METER

A. Manufacturer / Model

1. Hialeah 3-Phase 480/277VAC 250A CT meter, or equivalent

2.17 DC AND AC DISCONNECTS

A. Manufacturer / Model

1. Square D / 3 Phase 600 VAC 250A rated, or equivalent

2.18 WIRE LOOM

A. Manufacturer / Model

1. NTE Electronics Inc. SL-01 Split Loom or Approved Equal

2.19 LABELING

- A. Manufacturer / Model
 - 1. HellermannTyton or approved equal.

2.20 COMMODITY PRODUCT MANUFACTURERS

- A. All commodity products such as, but not limited to conduit, fittings, raceways, lugs, conductors, etc. shall be supplied by nationally recognized manufacturers and be made in the USA.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify field measurements are as shown on drawings before starting work.

3.2 COMPLETE INSTALLATION

- A. Install equipment in accordance with manufacturer's instructions.
- B. Comply with Manufacturer's recommendations on product handling, storage, and protection.
- C. All work and the execution of the same shall be completed in a first class, workmanlike manner by experienced and qualified trade persons, and shall conform to the best building practice.
- D. Access to the site shall be coordinated between Contractor and the Contractor. The Contractor shall be solely responsible for any damage caused by the Contractor's personnel or Contractor to properties and/or possessions of Contractor, the building Owner, and or its patron's.
- E. Throughout the job and during construction it is the responsibility of the Contractor to secure the job site from the public.

3.3 PV MODULE WIRING

- A. Record module serial numbers prior to installation.
- B. Test each module by measuring open circuit voltage (Voc). Replace any defective solar PV modules.
- C. All PV module wiring is to uniformly fold and fastened to, under and within the module frame to support and protect the conductor throughout.
- D. All PV module wiring to be secured with stainless steel cable clips for AWG 10 PV cable.

- E. PV wiring conductors from the first and last modules of each string to be run to the West end of each row. Sufficient length of continuous conductors for each string, with no splices or connectors, are to be provided for the Electrical Contractor to be able to route into metal wire-ways run north south between array rows.
- F. PV wiring conductors from the first and last modules of each string shall be allowed to be installed in the C-purlin of the racking system provided that conductors are grouped appropriately and that transitions into, out of, and between C-purlins are protected from sharp edges of the racking system by an appropriately - sized piece of UV rated split loom. The split loom shall be secured appropriately to the wires and extended at a minimum of 6" from each transition point.
- G. PV wiring conductors from the first and last modules of each string shall transition into metal wire troughs run between the arrays and inverters. Conductors shall be secured appropriately as they transition into, out of, and between metal wire-ways and racking rows. Wires shall be protected from sharp edges of the wire-way and from sharp edges of the racking system by an appropriately - sized piece of UV rated split loom. The split loom shall be secured appropriately to the wires and extended at a minimum of 6" from each transition point.

3.4 RACKING

- A. Install the solar PV system array per manufacturer's instructions including the slip sheets, ballast, mid span rail supports, racking rails, splice plates, expansion joints, mid and end clamps and PV modules.

3.5 BALLAST SLIP SHEET

- A. Furnish and install an EPDM slip sheet cut to 1" min in excess of ballast dimensions.
- B. Apply sufficient adhesive to adhere slip sheet to ballast block and mid span rail supports.

3.6 WIRE MANAGEMENT WITHIN THE MODULES

- A. Install SS wire clips in a uniform and consistent manner to secure and detail wire and MC Connectors to PV module frame to provide strain relief at the junction box and eliminate any slack for module whips and jumpers.
- B. Locate MC connectors away from direct sunlight and away from any rain or water flow off the module.

3.7 ARRAY RACEWAY

- A. Install the array DC output circuit raceway connecting each and all row racking rails to the combiner box.
- B. Allow gap at splice points for expansion and drainage

3.8 GROUNDING

- A. Install a bare solid equipment grounding conductor to each rail with a WEEB LUG assembly bolted to the racking system slot and routed along and within the raceway to each combiner box.

3.9 SOURCE CIRCUIT JUMPERS

- A. Install MC connectors on source circuit negative and positive PV wire jumpers and connect each string circuit to the appropriate combiner box.
- B. In order to identify the location of each end of the string within the sub-array, mark the associated combiner box and string number on the end module and associated rail, with a permanent marker in a clear, consistent readable manner.

3.10 WIRE MANGEMENT FOR STRING HOME RUN JUMPERS

- A. Wire support raceways will carry the source circuit conductors from the array strings to the combiner boxes.
- B. Install jumpers into raceway, entering the raceway under the module between the two module rails.
- C. Bundle jumpers together and secure into raceway with wire ties.
- D. Route the jumpers in the raceway to the Combiner Box.
- E. Install cordgrips at the Combiner Box
- F. Prior to entering the Combiner Box, provide a drip loop, wire loom and strain relief for the source circuits jumpers.

3.11 SOURCE CIRCUIT TERMINATION AND TESTING

- A. Install and test per standard Solar PV System Electrical Installation and Test Procedure.
- B. Terminate the source circuits in each combiner box for each sub-array.
- C. Label each conductor with the associated combiner box and string number.

3.12 ROOF PROTECTION

- A. All work on the roof will be mobilized and executed to assure the roof membrane is not penetrated. Protection is required for all walk and working areas. Minimum protection is ¼" plywood or EPDM membrane. Protection is required for all modules, racking, equipment, fasteners, parts, tools, trash cans, etc.
- B. All hole drilling will be done at a dedicated area equipped with a drop cloth over the plywood protection to assure no fillings drop or are blown onto the roof membrane.

- C. Construction of the electrical equipment structure will be on a dedicated area equipped with a drop cloth over the plywood protection to assure no fillings drop or are blown onto the roof surface.
- D. At the end of each work day, the work area will be completely cleaned and vacuumed of all scraps and cuttings.

3.13 INVERTERS

- A. Install inverters at the specified Inverter locations per the system design drawings and manufacturer recommendations.
- B. Assemble Support Structure using channel strut as required based on manufacturer recommendations.

3.14 SOLAR PRODUCTION METER

- A. Installation of a utility grade kWh meter (compliant to ANSI 12.1 standard) for recording gross solar energy production; this meter should be installed at the Inverter and Electrical Equipment location *before* the point of connection with the utility accessible AC Disconnect. Provide a solar production meter to record the system's power production on the main PV AC output circuit.

3.15 PV UTILITY DISCONNECT

- A. As required by the Local PSC interconnection regulation, the combined inverter output conductor shall be wired to a utility disconnect. The application to EDC Power Company is to request the PV utility disconnect to be located within sight of the AC Utility Meter.

3.16 LABELLING

- A. Label all equipment with the appropriate warnings and designations as required by NEC 2011 or most recently approved version by the AHJ Article 690 and 705.10 with permanent labels matching the existing facility labeling system.

3.17 MONITORING

- A. System monitoring to be installed using a LAN based internet network access point.
- B. The monitoring connection shall be made between the inverters and the Monitoring Device via Manufacturer provided specifications and approved materials.

END OF SECTION

SECTION 16400 - SERVICE AND DISTRIBUTION

The General Conditions, any supplementary General Conditions and Division 1, General Requirements, are hereby made a part of this section as fully as if herein.

PART 1 - GENERAL

1.1 Scope of Work:

- A. Work included:
 - 1. Complete electrical distribution system.
 - 2. Charges by utility company for their work, including sleeves and connections..
- B. Work included elsewhere: See Section 15010 - General Provisions (Mechanical), Section 16010 - General Provisions (Electrical).
- C. Unit Pricing: As part of bid, provide unit pricing for additional receptacles and local light switches, complete.

1.2 Submittals:

- A. Submit cuts on all items of electrical equipment. Include panelboards, switches, wiring, receptacles, motor starters, disconnects, wiring devices, cover plates, distribution equipment and over current devices.

PART 2 - PRODUCTS

2.1 Equipment:

- A. Disconnect Switches: Disconnect switches 30 amp through 400 amp shall be heavy duty type, Fusible, with solid neutral and shall fuse all ungrounded conductors. Unless otherwise specified, fuses at service entrance shall have 100,000 amp interrupting capacity, UL approved. Switches shall be rated as shown on contract drawings and shall be quick-make, quick-break with positive pressure fuse clips, externally operated cover, and interlocked handle with provision for padlocking in open or closed position. Enclosures shall be NEMA 1 except NEMA 3R where located outdoors or where accessible to the general public. Furnish additional locks where required. Switches shall be Square D or approved equal by ITE or Cutler Hammer.
- B. Fuses:
 - 1. All fuses shall be UL listed Class R, Class J and/or Class L (time delay). All fuse contact surfaces shall be electroplated, and fuse shall be so selected as to provide a fully selective coordinated system. Spare fuses shall be in a spare fuse cabinet and shall be as follows:

- a. Provide 10% of each rating (minimum of 3 per rating).
 - b. Service Entrance, Feeder Circuits, Motors, Motor Controllers, Transformers and inductive circuit fuses (600 ampere & smaller):
 - (1) Rated 1/10 amp to 600 amp, 250 volt AC, shall be UL listed Class RK1 or RK5 as required, current limiting with 200,000 ampere RMS interrupting rating. Fuse body shall be constructed of high temperature, dimensionally stable, long-life non-hygroscopic material.
 - c. Where short circuit current does not exceed 10,000 ampere RMS and for protection of individual equipment units fuses shall be rated 1 amp to 600 amp, 250 volt AC, shall be UL listed Class K-5 with 10,000 ampere interrupting rating.
2. Fuses shall be by Bussman or approved equal by Littlefuse, Reliance.

C. Circuit Breaker Panelboards:

1. Commercial grade, bolt-on circuit breaker type with locking covers and with typed directories inside the covers. All components shall be UL listed and where applicable labeled suitable for service entrance. Panelboards shall be Square D NQOD or equal by Cutler Hammer or ITE.
2. Commercial grade, plug-on circuit breaker type with locking covers and with typed directories inside the covers. All components shall be UL listed and where applicable labeled suitable for service entrance. Panelboards shall be Square D 'I-LINE' series or equal by Cutler Hammer or ITE. If substitute non-plugin panel(s) are provided, the panel(s) shall be factory equipped with circuit breaker mounting kits for mounting of 14 circuit breakers. The owner shall not be required to purchase any accessories or mounting kits to install a breaker at a later date.
3. Provide panelboard mounted transient voltage surge suppression (TVSS) on the service panel and additional locations where indicated on the drawings and panel schedules. The TVSS shall comply with UL 1449 Third Edition. Provide Innovative Technologies protector services with the following specification. (PTE, or PTX for GFI application.)
 - a. ANSI/IEEE C62.41 locations category A, B, C.
 - b. Peak surge current 160 KA/phase.
 - c. 20 year free replacement warranty.
 - d. Audible alarm, surge counter, and phase loss monitor.

The surge suppressor shall be mounted straight out from the circuit breaker so that the lead wiring feeding the unit does not exceed 12 inches. Equals must meet or exceed specifications for let-thru and energy

withstand and warranty.

4. Ampere ratings and "total spaces" numbers on panel schedules are given as minimum requirements. A panelboard will not be construed as meeting the specifications unless both these minimum requirements are met or exceeded.

2.2 Circuit Breakers:

- A. Circuit breaker used for HACR or hid lighting loads shall be UL Listed for their intended purpose.
- B. All lugs and breakers shall be rated at 75°C minimum.

2.3 Motor Snap Switches:

- A. Motor snap switches shall be provided with toggle lock-off handle guard.
- B. Flush mount where wall mounted in finished areas.
- C. Motor snap switches shall be Arrow-Hart 6808-GD (10) or 7810-GD (30).

2.4 Contactors:

- A. Industrial Duty rated for 600 volts.
- B. Totally enclosed silver alloy break power contacts. Main contacts suitable for all loads without the use of auxiliary arcing contacts.
- C. Coils continuously rated and encapsulated.
- D. 2-wire or 3-wire control as required for the circuits indicated.
- E. Mounted in a NEMA-1 enclosure unless otherwise indicated on the drawings.
- F. Contactors shall be Square-D Class 8903 or equal by Cutler, Hammer, or ITE.

2.5 Wiring Methods:

- A. In general, branch circuits shall be No. 12 AWG (minimum) THHN copper. Control wiring and signal circuits may be No. 14 AWG THWN/THHN.
- B. Wiring shall be concealed within walls, ceilings and floors.
- C. Electric room wiring raceways may be installed exposed. Exposed wiring shall be installed in a neat and workmanlike manner with runs plumb and parallel to walls.

- D. All wiring shall be supported in accordance with provisions of National Electrical Code and local code requirements and shall utilize approved fasteners and clamps. Conduits secured to walls shall be fastened to wall studs where spacing permits. In all cases, conduits and clamps shall be rigidly secured and free of obtrusions which may cause injuries.
- E. Wiring shall be color coded to distinguish between services of different voltages. Use distinctive color for switched conductor wherever possible. Color coding to be as follows:

<u>Voltage</u>	<u>Neutral</u>	<u>Phase A</u>	<u>Phase B</u>	<u>Phase C</u>	<u>Ground</u>
120/240 Wye	White	Black	Red	Blue	Green

- F. All No. 12 and No. 10 branch circuit conductors shall have solid color compound or solid color coating. All neutral sizes shall have solid color compound or solid color coating.
- G. No. 8 AWG and larger phase conductors shall have either:
 1. Solid color compound or solid color coating.
 2. Stripes, bands or hash marks of colors specified above.
 3. Colored, pressure-sensitive plastic tape. Tape shall be applied in half overlapping turns for a minimum of three inches for all terminal points, and in all junction boxes, pull boxes,. Tape shall be 3/4-inch wide with colors as specified above. The last two laps of tape shall be applied with no tension to prevent possible unwinding. Where cable markings are covered by tape, apply. Tag all wires at terminal equipment, outlets, terminal cabinets pull and junction boxes, and control center, with Brady "Quick" label tags.
 4. Circuit number and panel identification shall be painted on the back of all device plates, on all receptacles and wall switches.

2.6 Wiring Devices:

- A. Switches shall be extra hard use, commercial premium specification grade and comply with Federal Specification W-S 896B and be rated 20 amperes and voltage as dictated by the system and shall not require derating for lamp loads. They shall be approved for control of motors up to 80 percent of the switch rating and shall be quiet AC type. Use single pole, double pole, three way and/or four way as shown connected. The color shall be ivory, white, or brown to suit wall finishes and shall be P&S, Leviton, Arrow-Hart, Hubbell, or General Electric.
- B. General use Receptacles - Receptacles shall be extra hard use, commercial

premium specification grade, two pole, three wire, straight blade type and shall comply with Federal Specifications W-C 596G with a rating of 20 amperes. The color shall be ivory, white, or brown to suit wall finishes and shall be P&S, Leviton, Arrow-Hart, Hubbell, or General Electric.

- C. Ground Fault Interrupter devices shall be duplex receptacle type and shall comply with Federal Specifications WC-596G and Underwriters Laboratories Inc. standard 943, Class A. They shall be no more than one and one eighth inch deep with standard terminal screw connections and rated at 20 amperes. The color shall be ivory, white, or brown to suit wall finishes and shall be P&S, Leviton, Arrow-Hart, Hubbell, or General Electric.
- D. Device plates: Indoors: .040 inch, brushed type 302 stainless steel.
- E. Device plates Weatherproof for outdoor and wet locations: Receptacle covers shall be cast aluminum and comply with 2002 NEC and shall provide “ protection while in use”. Provide Intermatic #WP1010MC, WP1010MCH for single gang applications, or approved equal. Weatherproof Switch plates shall also be cast aluminum, UL listed for wet locations.

2.7 Connections to Mechanical Equipment:

- A. Note carefully all other sections of this specification (in particular Division 15) describing electrical equipment to be furnished in order to fully understand all equipment wiring and motor starting requirements.
- B. An enclosed disconnect switch and motor starter shall be furnished and installed for each motor installed unless specifically indicated as furnished under other sections of specifications.
- C. All thermostats shall be furnished and installed under Division 15.
- D. Furnish and install all power wiring for motors complete from panelboard thru motor starters to motor terminations.

2.8 Grounding:

- A. Furnish, install and connect ground bond to cold water services and to auxiliary driven ground rods. Bond all non-current carrying metallic parts of equipment, mechanical systems, and building steel. Neutral conductor at main switches shall be grounded. Ground bus shall not be less than size required by National Electrical Code and local codes. Grounding system shall be complete and installed in accordance with all local jurisdictions and Owner's requirements. Ground rods shall be copper clad steel, driven as indicated, or to refusal. Where soil conditions are poor notify the Architect so that supplemental grounding may be considered. Ground and bond all piping systems within building.

2.9 Ground Network:

- A. A ground network for service grounding shall be provided. Where rock is encountered, horizontal rods of cable shall be installed in accordance with the National Electrical Code and as directed by the Owner. After each ground rod is driven, the Contractor shall measure the ground resistance of each rod and submit a written report indicating the resistance of each rod. Owner shall review the report and determine if additional ground rods are to be driven. After Owner's review of test report, Contractor shall install ground rod connections. After system is complete and before the network is connected to the electrical system the Contractor shall perform a final resistance test of the network and submit a report in writing to Owner. Test reports shall indicate date, outdoor temperature and equipment model number. Ground tests shall be made using equipment specifically designed for the purpose as manufactured by Bidle, or equal.
- B. Ground rod connections and building steel bonds shall be Cadweld connections. Lugs for equipment connections shall be compression type.

2.10 Temporary Service:

- A. Make provision for and install temporary service for power as may be required for entire contract limits.
- B. Exact location of temporary service delivery point shall be as agreed upon by utility company, Architect and Owner.
- C. Contractor's installation of temporary service shall comply with all applicable codes and regulations and shall include Ground Fault Interrupters.

2.11 Power Company Coordination:

- A. Contractor to provide site facilities as per power company's requirements.
- B. Contractor shall not do any rough-in of empty conduits, meter sockets, etc. until the power company has produced engineered drawings indicating exact locations and conduits required.
- C. The contractor shall contact the Power Company and coordinate the electrical service connections.

PART 3 - EXECUTION:

3.1 Installation:

- A. Switches and receptacles shall be installed in locations shown on contract drawings. Contractor shall study general building plans in relation to space surrounding each device in order that intended work may accommodate all other specified work. Boxes shall be installed in a rigid and satisfactory manner. Support all boxes independent of raceways. Adjacent wall mounted wiring devices, room thermostats or other equipment shall be coordinated and so located either at the same elevation or in line, one above the other. Install conduit, outlets

and equipment to clear beams or obstructions. Do not cut into or reduce the size of any load-carrying member without the approval of the Engineer. Permission of resident Architect shall be obtained before cutting any existing structural concrete walls or floors. Check drawings and work of others to prevent interference. Deviations of work to avoid obstructions shall be done without additional cost.

- B. Ground all equipment in accordance with the National Electrical Code requirements and with local ordinances and utility company requirement.
- C. Mount top of panelboards 6 feet 2 inches above floor unless otherwise noted. Secure to studs or erect supporting frames.
- D. Where panelboards are recessed, conceal raceways connected to them. Furnish bulkheads and wall framing where semi-recessed mounting is required.
- E. Mounting heights, unless otherwise specified:
 - 1. Receptacles - 18 inches.
 - 2. Where receptacles are mounted at counters, they shall be 8 inches above counter height and shall clear any splash board provided with counter.
 - 3. Wall switches - 48 inches.
 - 4. Where applicable, mounting heights shall conform to Handicap Code for Barrier Free Installations.
- F. All wiring devices shall be wired using the screw terminals. Push connections are not acceptable.
- G. Wiring shall be run in heavy wall conduit where installed below vapor barrier.
- H. Support pull boxes and junction boxes in ceiling from structure and not from raceways or ceiling suspension systems.
- I. Use locknuts and insulating bushings at all rigid conduit ends at junction boxes, pull boxes, panel, starters, disconnects, and other boxes.
- J. Protect conduit openings and do not pull wire until work which could damage wire has been completed near ends of conduit. All empty raceways shall be furnished with nylon rope.
- K. Bend conduits with hickey or bender, where bends are necessary. Do not bend in vise or use a pipe tee for bending.
- L. When cutting conduit, square ends, thread, ream and clean.
- M. Use Sealtite conduit and fittings in damp places for pumps, motor connections, in

mechanical equipment rooms or out of doors for flexible connections.

- N. Use gasketed covers and threaded raceway hubs for exterior raceway connections. Use vandal-resistant hardware where accessible to public.
- O. Label all safety switches, disconnects, panelboards, motor starters, motor service switches and other equipment with engraved laminated plastic tags, screw attached, not smaller than 3/8 inch high, indicating function served. Letters shall not be smaller than 1/4 inch high and shall be black on white background. Submit proposed designations and sample for approval. Panelboard nameplates shall also indicate the panel and circuit it is fed from as well as Voltage/phase, feeder circuit breaker ampacity and date.
- P. No more than three phase conductors shall be installed in a conduit without derating the conductors as per NEC. All sizes given on the plans are for 3 max current carrying conductors.

3.2 Guarantee:

- A. Unless otherwise specified, guarantee unconditionally for a guarantee period as set forth in General Conditions all materials, equipment, workmanship and installation. During this period, adjust, repair or replace at no cost to Owner any item of equipment or workmanship found to be defective.

(END OF SECTION)

SECTION 16500 - LIGHTING

The General Conditions, any supplementary General Conditions and Division 1, General Requirements, are hereby made a part of this section as fully as if herein.

PART 1 - GENERAL

1.1 Scope of Work:

- A. Work includes furnishing, storing, installing and connecting all fixtures, complete for continuous satisfactory operation. Included is furnishing mounting brackets, stems, frames, plaster rings, and trim required to match surrounding surface.

1.2 Submittals:

- A. Refer to Section 16010, GENERAL PROVISIONS, in particular regarding submission on alternate products and form of submittals.
- B. Contractor shall verify ceiling types and coordinate trim and mounting hardware prior to submission of fixtures to insure proper compatibility of fixture type with ceiling system. Should a conflict be found, the contractor shall contact the Architect/Engineer for clarification.
- C. Manufacturer's model and catalog numbers, change frequently and may not necessarily include all features or options as specified herein or required for complete installation. In particular, catalog number may only indicate type and series of required fixture. When specified types, finishes, features, options or accessories conflict with given model number, the written description shall govern. Contractor shall bear final responsibility for insuring that fixtures delivered to jobsite completely conform will all specifications and features as specified herein and are approved for installation in intended location. Voltage shall be as indicated on drawings.
- D. Substitute light fixtures shall be submitted with photometrics. All outdoor fixtures shall be submitted with a footcandle chart indicating footcandle levels at the mounting height the fixture is to be installed. Light levels shall be given to at least 4 mounting heights in all directions as applicable.
- E. Submit cuts of all fixtures furnished, samples when requested, lamped for display.
- F. Under base bid furnish fixtures and equipment specified or named equals (Note: named equals shall not be considered the specified equipment). Where no named equal is given and only "or approved equal" is noted, Contractor may at his option use alternates of his selection, however, such alternate MUST conform to the specified fixture's or item's construction performance and catalog features and shall have a similar aesthetic appearance. Failure to conform will result in rejection of item.
- G. When a named equal is submitted in place of the one specified, it will only be

considered if equivalent in quality, construction performance, similar features and aesthetic impact. Fixtures will not be evaluated unless complete photometric data is submitted along with photograph cuts. Alternate fixtures will not be evaluated unless complete photometric data including ITL or ETL Test Report, Isolux diagrams, fixture efficiency, candela chart and point-by-point comparison calculations are submitted. One submittal shall be composed of original catalog sheets complete with photometric data, remaining others may be photo-copies of the original.

- H. Submittals shall be in a covered brochure form and include a cover page indicating specified type, manufacturer's catalog numbers, and fixture description. Where multiple types are indicated on sheets, the proposed item shall be clearly identified.
- I. Substitute fixtures when named alternates are specified will not be considered unless they are named on an addendum as an equal that is issued 7 days prior to the bid date.
- J. Final choice and review of finishes and colors shall be made by Architect at time of submission at no charge in contract price.

PART 2 - PRODUCTS

2.1 General Equipment:

- A. Fluorescent ballasts: Type P automatic thermal resetting, multivolt (100 - 300 volt input) CBM approve, "A" sound rated, high power factor, electronic solid state, 10% THD. In low ambient temperature areas, provide low temperature ballasts (O Deg F) and where otherwise required by high ambient conditions, high ambient, heat sink ballasts shall be used. Ballasts shall be General Electric, Advance, Universal.
- B. Fluorescent lamps: 48 inch, F32-T8, 41k, by low Mercury type, General Electric, ALTO or equal by Phillips, Sylvania.
- C. Lighting fixtures shall bear label of Underwriters' Laboratories, Inc. and shall be suitable for intended location. Fixtures shall be labeled indicating suitability for damp or wet locations where required.
- D. Each fixture shall be supplied with necessary straps, supports or hangers, or other miscellaneous materials and devices to install them in a satisfactory manner to conform to architectural treatment and finishes in area in which they are to be installed. Consult all Mechanical, Architectural and Structural plans and related contract documents to be familiar with all necessary details for proper fixture placement. Failure to do so will not relieve Contractor of responsibility of furnishing all necessary material, complete to perform function intended for indicated lighting system.
- E. Exit sign color shall be as required by local code. Furnish single or double faced

with directional arrows as required by installation and field visual conditions.

2.2 Lighting Fixtures:

- A. All fixtures furnished shall be standard manufacturer's cataloged and stocked fixtures. Specially fabricated fixtures, unless so specified, will not be accepted. Replacement parts and lenses shall be readily available from manufacturer. Fixture voltages shall be as shown to be connected on drawings.
- B. Lighting fixture schedule: (Refer to drawings.)

2.3 Outdoor Light Control:

- A. All outdoor lighting shall be controlled by a two channel time clock. Normal exterior lighting circuits shall operate dusk "on", time clock "off". Night light circuits shall operate by dusk-to-dawn.
- B. Photo-control shall be cast aluminum type with field adjustable light window opening and be of sufficient capacity to operate indicated loads. Photo control shall be mounted on building roof at height above roof drains and below visual sight lines. Photo control shall be equal to Stonco P-150 Series.
- C. Time clocks: Lighting control time clocks shall be photo initiated, 7 day calendar dial with 7 day quartz reserve. Photo control shall override timer and turn lights on at dusk and off at dawn regardless of timer. Time control shall carry load and turn lights off at preset time. Manual lever shall override automatic controls without disturbing preset schedules. Clock shall have a light indicating photo control operation. Enclosure shall be NEMA 1 with hasp for padlock. Furnish lock. Time clock shall be equal to Paragon 76180 Series or Tork, Sangamo.

2.4 Occupancy Sensor Controls:

- A. Power Packs.
 - 1. Provide power packs for all low voltage motion detectors.
 - 2. Input voltage to be 120 or 277 to match light fixture.
 - 3. Secondary voltage of 24 VDC.
 - 4. Secondary output of 150 mA, 114 mA with relay connected.
 - 5. Low voltage leads are rated for 300 volts.
 - 6. UL-rated 94V-0 plastic enclosure.
 - 7. UL 2043 plenum rated.

8. Dimensions: 1.6" x 2.7" x 1.6" (41mm x 70mm x 41mm) with a ½ inch snap-in nipple.
9. UL and CUL listed; five year warranty.

B. Passive Infrared Sensors.

1. Provide at locations shown on the drawings.
2. 24 VDC/VAC.
3. Time delays: SmartSet (automatic), fixed (5, 10, 15, 20, or 30 minutes), walk-through, test-mode.
4. Sensitivity adjustment: SmartSet (automatic) or reduced sensitivity.
5. Multi-level, 360⁰ Fresnel lens for superior occupancy detection.
6. CI-300 contains isolated relay with N/O and N/C outputs; rated for 1 Amp at 30 VDC/VAC.
7. Built-in light level sensor (CI-300) – works from 10 to 300 footcandles (107.6 to 3,229.2 lux).
8. Mounting options: ceiling tile; 4 square junction box with double gang mudring.
9. Units per power pack: CI-300 up to 5 (B), up to 7 (BZ); CI-305 up to 12 (B), up to 16 (BZ).
10. Dimensions: 4.5" diameter x 1.02: deep (114.3mm x 25.9mm).
11. UL and CUI listed; five year warranty.

C. Ultra Sonic Ceiling Sensor.

1. Provide at locations shown on the drawings.
2. Solid state, crystal-controlled (25 kHz \pm 0.005%).
3. Temperature and humidity-resistant 25 kHz receivers, W-500A contains 1 receiver, other models contain 2 receivers.
4. Time delay adjustable from 15 seconds to 15 minutes.
5. Mounts to ceiling tile or 4 square junction box.
6. Units per power pack: up to 7 (B); up to 9 (BZ).

7. Dimensions: 4.5" x 4.5" x 1.25" (115mm x 115mm x 32mm) W x L x D.
 8. UL listed; five year warranty.
- D. Dual Technology Sensors.
1. Provide at locations shown on the drawings.
 2. 24 VDC/VAC.
 3. Ultrasonic frequency of 40 kHz.
 4. Time delays: SmartSet (automatic), fixed (5, 10, 15, 20, or 30 minutes), walk-through, test-mode.
 5. Sensitivity adjustment: SmartSet (automatic) or reduced sensitivity (for PIR sensitivity); ultrasonic sensitivity is variable with trimpot.
 6. Built-in light level sensor (DT-300) – works for 10 to 300 footcandles (107.6 to 3,229.2 lux).
 7. Low voltage, momentary switch input for manual ON or OFF operation.
 8. DT-300 contains an isolated relay with N/O and N/C outputs; rated for 1 Amp @ 30 VDC/VAC.
 9. Multi-level, 360⁰ Fresnel lens for superior occupancy detection.
 10. Mounting options: ceiling tile; 4 square junction box with double gang mudring.
 11. Units per power pack: DT-300: up to 2 (B), up to 3 (BZ); DT-305: up to 3 (B), up to 4 (BZ).
 12. Dimensions: 4.50" diameter x 1.02" deep (114.3mm x 25.9mm).
 13. UL and CUL listed; five year warranty.

PART 3 - EXECUTION

3.1 Installation:

- A. Support fluorescent fixtures from structure above and screw fasten to grid. Do not support from acoustical tiles. Provide rigid hangers or framing to support units. Install grid clips for troffers. Provide additional hangers to achieve one support at each troffer corner.
- B. Install plaster rings or frames where fixtures are recessed in plaster ceilings.

Install matching trim for fixtures in other types of ceilings.

- C. Coordinate fixture locations with ceiling framing and equipment locations. Align all continuous row fixtures in uniform rows. Furnish metal channels to achieve alignment, if required. All fixtures shall be supported securely with approved hangers. Such hangers shall be set in perfect alignment and elevation.
- D. The contractor shall provide the required unistrut, chains, hangers, all thread, etc. to hang light fixtures in areas without suspended ceilings.
- E. Each outdoor light fixture incorporating a ballast shall be individually fused with an in-line fuse for each underground connector installed in fixture connection box or ballast compartment, where U.L. listing permits.
- F. Outlet mounted fixtures shall be mounted directly to mounting ears of outlet box or to fixture studs as required by selected fixture. Furnish structural supports for heavy fixtures.
- G. All splices shall be carefully placed in outlet boxes or wiring gutters with no crowding in a neat and orderly manner.
- H. Light fixtures shall not be used as raceways. Furnish boxes at each fixture where multi-circuit homeruns are used.
- I. Upon completion of above work and prior to final acceptance of building, each fixture shall be equipped with proper number of new lamps of specified size, all in good operating condition. Replace any lamp or ballast which appears to be defective or noisy or of the wrong color, in opinion of Architect. Fixtures shall be clean at time of acceptance.
- J. Exterior boxes shall be bronze and have tamper resistant hardware.

3.2 Guarantee:

- A. Unless otherwise specified, guarantee unconditionally for guarantee period as set forth in General Conditions, all material, equipment, workmanship and installation. During this period, adjust, repair or replace at no cost to Owner any item of equipment or workmanship found to be defective.
- B. Lamps shall be guaranteed for 90 days after final acceptance.

(END OF SECTION)

SECTION 16720 - ADDRESSABLE FIRE ALARM SYSTEM

The general conditions, any supplementary General Conditions and Division 1, General Requirements, are hereby made a part of this section as fully as if repeated herein.

PART 1 - GENERAL

1.1 Scope of Work:

A. Work Included:

1. Fire alarm system as specified and as required by Code.
2. Provide duct smoke detectors and HVAC unit control. Duct smoke detectors shall be furnished and installed by this section.
3. Testing of the fire alarm system shall be performed in front of the owners and the Local Fire Marshal's representatives.

B. Related work elsewhere: Section 15500 - Fire Protection System, Section 15900 - Automatic Temperature Controls.

1.2 Codes and Standards:

- A. NFPA Standards 101, 72A, 90 latest editions.
- B. National Electrical Code, latest edition.
- C. Local building code.
- D. Requirements of local Fire Department.
- E. NFPA Standard 90A, latest edition.

1.3 Qualifications:

- A. All major items shall be products of one United States manufacturer regularly engaged in production of such equipment, who has maintained in this area a maintenance and service organization for a period of two years where skilled, factory trained men are available on a 24 hour basis.

1.4 Certification:

- A. The contractor shall provide the services and equipment of an alarm service company listed by Underwriters Laboratories Inc., in its Directory as being capable of furnishing the signaling systems specified herein and who is authorized to, and shall, issue a certificate to the equipment described herein as its representation that such equipment and all connected wiring and devices which form the specified system together with installation and maintenance service are

in compliance with the requirements established by Underwriters Laboratories Inc.

1.5 Submittals:

- A. Complete fire alarm system and detection system, wiring diagrams, color coding, all system components.
- B. General Submittal Requirements.
 - 1. Number of copies: six to general contractor, three to local fire marshal.
 - 2. Provide floor plan blue print drawings with each set of submittals.
 - 3. A submittal shall consist of equipment cuts, drawings, wiring diagrams, risers, sequence of operations, battery calculations.
- C. Drawings.
 - 1. Project name and address (include all addresses if more than one bldg).
 - 2. Project owner's name and address including zip code (tenant for tenant work; building owner for shell work).
 - 3. Building construction permit number, if available.
 - 4. Contractor name, address, telephone number, and contact person.
 - 5. Symbol and abbreviation key.
 - 6. Minimum scale for floor plans is 1/16" per ft.
 - 7. Occupancy of all rooms and areas.
 - 8. Location of all partitions.
 - 9. Rating of any fire walls, partitions, doors, and associated detection.
 - 10. Smoke partitions, doors, duct penetrations, and associated detection.
 - 11. Graphic annunciator detail.
- D. Equipment.
 - 1. Include catalog cuts for all equipment to be used.
 - 2. For system additions, submit existing equipment catalog cuts for coordination and to check compatibility.

3. Annotate all catalog cuts to show exact model(s) to be used.
 4. Include system devices provided by others such as duct detectors and door holders.
- E. Wiring Diagram.
1. This must be a point-to-point diagram showing all terminal connections at devices and panel(s).
 2. Typical circuits or devices may be shown once.
- F. Sequence of Operations.
1. For all initiating devices, show all system outputs such as audible & visual devices, annunciation, door & damper closure, AHU shutdown, door unlocking, smoke control system activation, sprinkler system activation, etc.
- G. Battery Calculations.
1. Show all devices and current draw.
 2. Provide the required alarm and supervision time.
- H. Send the submittals to the State Fire Marshal's office for review no later than 30 days after award of the contract. Make corrections as required by the Fire Marshal's office and resubmit until the submittal has been approved. The contractor shall include all cost associated with producing one resubmittal as part of the contract.

PART 2 - PRODUCTS

2.1 Fire Alarm System:

- A. General:
1. Provide a complete and integrated fire alarm system, including an addressable multiplexed main control panel, addressable manual fire alarm stations, duct smoke detectors, smoke detectors, graphic annunciator; digital communicator and all required outlets and wiring.
 2. Make connections to all duct smoke detectors, alarms and initiating devices, and related systems furnished under other contracts
 3. Operation of any detector, manual station shall sound a continuous alarm on all audible alarms and flash all visual alarms. All alarms shall continue until manually reset. Receipt of an alarm from an initiating device shall have priority and shall not be inhibited in trouble mode.

4. System as specified herein shall be addressable Simplex 4010, Edwards, Notifier, Silent Knight. Equals shall be compatible and UL listed to service the existing fire alarm system components.
5. Wiring shall generally be in accordance with sections of this division except that minimum wire size for detector or contact device circuits shall be no. 22 AWG THHN and No. 12 AWG THHN for signal circuits. All wiring shall be in EMT or red Fire Alarm MC Cable and shall comply with the requirements of 16100.
6. Locations for all ceiling mounted equipment shall be coordinated with lights, air outlets and other ceiling fixtures, and shall be acceptable to the Architect.
7. System shall be installed in accordance with manufacturer's recommendations, by or under direct supervision of an authorized factory trained representative. Manufacturer shall provide complete wiring diagrams for the entire system and it shall be submitted for approval. All tests and adjustments shall be made by manufacturer's representative.
8. Make provisions for telephone company connection. Provide 3/4 inch EMT conduit to telephone service terminal equip., connect to dedicated line, & test.
9. Install required digital communicator interconnect wiring for proper operation.
10. All equipment shall be listed by Underwriters' Laboratories, Inc., for service in accordance with NFPA Standards 72, latest editions, and all components shall be approved by the local fire inspection approving agency.
11. Installation of system shall comply in all respects to NFPA Standard 72, and NFPA Standard 90A, "Air Conditioning and Ventilating Systems".
12. Smoke detectors specified hereafter shall have be listed in accordance with Underwriters' Laboratories UL-268, standard for commercial detectors and shall have approval from the State Fire Marshal's Office. Detectors which do not meet this standard shall not be considered as complying with intent of this specification.
13. All strobe circuits shall be loaded no more than 75% of capacity.

2.2 System Operation:

- A. Actuation of any fire alarm station or smoke detector shall:
 1. Automatically operate fire alarms in building in which item was activated, and initiate digital communicator.

2. Initiate flashing fire strobes.
 3. Activate annunciators on fire alarm panel and remote annunciators indicating zone and building in which station or detector was activated.
 4. Activate a set of auxiliary dry contacts (DPDT).
 5. De-energize all sound address systems.
- B. Activation of a HVAC duct detector or manual HVAC shut-down switch shall:
1. Shut down the HVAC unit by the use of supervised relays, and all associated compressors.
 2. Activate a supervisory trouble.
 3. Indicate HVAC unit in alarm on the fire alarm control panel and annunciator.

2.3 Equipment:

- A. Main control panel shall provide power and necessary components for operation of supervised alarm initiating circuits, supervised tamper circuits and supervised alarm signal circuits utilizing 24 volt DC devices.
- B. Construction shall be modular with solid state, microprocessor based electronics. Visual indicates shall be high contrast, LED type. Type control panel shall contain the following features:
 1. 127 zone addressable interface.
 2. Eight 2 amp alarm indicating appliance circuits (provide supplemental power supplies as required).
 3. Two form C alarm contacts.
 4. Two form C trouble contacts.
 5. Earth ground supervisory circuit.
 6. Automatic battery charger and batteries.
 7. Surge suppressor on each line feeding from remote buildings.
 8. Sixteen programmable contacts for control of HVAC units.

2.4 Operation:

- A. Primary power for system shall be from a 3 wire, 120 volt AC supply.
- B. Operation:
 - 1. The addressable controller continuously interrogates each addressable device on the communicator channel for status condition such as: normal, off-normal, alarm, or trouble. Sophisticated poll and response communication techniques ensure supervision integrity and allow for "T-tapping" of the circuit. Using a twisted, shielded pair of #18AWG wire, a maximum of 10,000 feet of wire.
- C. Alarm signal circuits shall consist of a 2 wire circuit terminating in an end-of-line device. Circuit shall be fused. A yellow LED indicating lamp (one for each circuit) shall illuminate on face of control panel should a break occur or an alarm line be shorted when system is in normal condition.
- D. End-of-line devices shall be located in a separate, covered, recessed box at end of each circuit and shall have red engraved plastic tags indicating zone designation, screw attached to cover. Cover shall be brushed, 302 stainless steel.

2.5 Annunciators:

- A. Provide one Alphanumeric Annunciator located as directed by the fire marshal. The Annunciator shall be flush mounted with a 40 digit display, with reset, test, trouble tone and trouble silence.
- B. Provide one Graphic Annunciator as detailed on the drawings. Provide a UL listed compatible to the system furnished. WSA or equal

2.6 Standby Battery:

- A. Provide an integral gelled electrolyte, lead-acid battery in each control cabinet to power the entire fire alarm system, including detectors, audible and visual alarms, annunciators and manual devices. Batteries shall have sufficient capacity to operate 24 hours in standby mode and 10 minutes in full alarm mode. Furnish integral automatic chargers to fully re-charge the batteries within 24 hours of power restoration, after a full discharge. Size batteries at 125% of calculated requirement. System shall be U.L. listed for intended purpose.

2.7 Automatic Devices: (Individually Addressable)

- A. General: All detectors shall permit changing detector type (ionization, photoelectric, or thermal) without necessitating base, zone or control panel rewiring.
- B. Smoke detectors shall be a plug in unit containing photoelectric detection chambers. It shall operate from a 24 volt or less DC power source, and shall contain an alarm indicator LED to signal actuation of detector. It shall also be possible to connect a remote relay to detector.

2.8 Strobe Power Supplies:

- A. The power supply shall be a standalone power supply intended for powering fire alarm notification appliances via its own Notification Appliance Circuit(s) (NAC). The unit shall be UL 864 Listed for power limited operation of outputs and comply with NFPA 70 (NEC), article 760. The power supply shall support a full 8A of notification power even if the battery is in a degraded mode and only AC power is connected.
- B. The power supply shall be activated by a standard Notification Appliance Circuit (NAC) from any Fire Alarm Control Panel (FACP) or a "Dry Contact" opening. The units shall be 8 ampere, 24 VDC, regulated and filtered, supervised remote power supply/charger. It shall operate over the voltage range of 8 to 33 VDC or FWR. The primary application of the unit shall be able to expand fire alarm system capabilities for additional NAC circuits to support ADA requirements and to provide auxiliary power to support system accessories or functions. The power supply shall provide four Class "B", two Class "A" or two Class "B" and one Class "A" NAC circuit(s). Eight Class "B" or four Class "A" circuits shall be available with an optional PS-EXP module. The PS-8 unit shall supply up to 240 mA of auxiliary power that is available during both non-alarm and alarm or auxiliary power to not less than 2.5A at 24 VCD during non-alarm. The power supply shall be capable of charging batteries of up to 33 ampere hours per NFPA 72 at maximum rate of 0.750 Amps per hour.
- C. Input activation options shall be from not less than two NAC circuits or Dry Contact closures. These inputs shall have the capability of being directed to any combination of the four NAC circuit outputs. Each NAC circuit output shall be rated at 3 amperes for Class "B" applications or 3 amperes each for Class "A". The outputs shall be programmable to generate a steady or Temporal (Code 3) output and or a synchronized strobe or horn output. The power supply shall provide independent loop supervision for either Class "A" or Class "B" FACP NAC circuits and shall have the capability to "steer" all alarm or trouble conditions to either incoming NAC circuit. The units shall have common trouble terminals. The power supply shall be powered from a 120 VAC source with a current consumption of xx amperes max. the unit shall incorporate short circuit protection with auto reset. The power supply shall incorporate a built in battery charger for lead acid or gel type batteries with automatic switchover to battery backup in the event of AC power failure. The charger shall incorporate fused protection for the batteries and have the ability to report low battery and/or no battery conditions(s). Standby current for battery backup shall be 0.129 Amps max. The power supply shall have the ability to latch trouble LED's so the circuit in trouble can be identified. The cabinet dimensions shall be 17" H x 15" W x 5.5"D.

2.9 Alarm Devices:

- A. Audible/visual signal devices shall be 24VDC, flush mounted combination horn/strobe light assemblies. Strobe light shall be a Xenon flash tube, 15, 30, 60

or 110 candela with Lexan lens and red lettering. Where wall depth permits, unit shall be flush mounted. Lamp and horn shall be polarized for supervision. Horn shall be rated at 95 db measured at 10 feet. Unit shall be framed in a **white** front panel with word "FIRE" in red lettering. Units shall be wall or ceiling mounted as noted on the drawings.

- B. Visual devices shall be similar to A/V devices except that no horn shall be provided.

2.10 Manual Fire Alarm Stations: (Addressable)

- A. Manual fire alarm stations shall be double action, of non-code type, and shall consist of a molded housing fitted with a pull-down lever and a push-in tab first to provide access to pull-down lever which when operated locks in position after releasing a spring loaded contact switch to effect actuation of alarm circuit. Body of manual station shall be hinged to a backplate assembly to which it is locked with a screw. Resetting the station after operation shall require opening station momentarily and then locking body to backplate. Provision shall be made for surface or semi-flush mounting to conduit boxes.

2.11 Digital Communicator:

- A. Provide a dual line, 8 zone digital communicator with battery back-up. Unit shall be activated by fire alarm panel and shall signal an UL listed central station. Provide line seizure module and connect to telephone system. Systems shall separately signal fire alarm and system trouble. Integral or separate digital communicators are acceptable.
- B. Include a 1 year service contract to monitor this system as part of the bid.

2.12 Addressable Duct Detectors:

- A. Duct smoke detectors shall be of the solid state photoelectric type and shall operate on the light scattering photodiode principle. The detectors shall be designed to ignore invisible airborne particles or smoke densities that are below the factory set alarm point. No radioactive materials shall be used. Detector construction shall be of the split type, which is, mounting base with twist-lock detecting head. Contacts between the base and head shall be of the bifurcated type using spring-type, self-wiping contacts. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control panel. Duct housing couplings shall be slotted to insure proper alignment of the sampling and exhaust tubes. Detector shall have an alarm LED visible through a transparent front cover. Detectors shall obtain their operating power from the supervised current in the fire alarm loop. Installation must comply with NFPA-90A.
- B. A manual control switch shall be provided at the annunciator at the main entrance for control of all HVAC fans. The switch shall have hand-off-auto positions. The contractor shall provide a polycarbonate shield over the switch which shall sound

a local audible alarm. Activation shall also activate a supervisory alarm on the fire alarm system.

2.13 Programmable relays:

- A. Programmable relays shall be provided for control of HVAC unit shutdown. Relays shall have contact ratings of 15 amp 120 volts. Provide supplemental relays as required if the relay from the fire alarm manufacturer does not meet these specifications.. One relay shall be required for shutdown of each HVAC unit, either by smoke detector activation or by the manual shut-down control at the front door.

2.14 Spare Parts:

- A. Provide the following spare parts:
 - 1. 2 – Smoke Detectors
 - 2. 2 – Heat Detectors
 - 3. 1 – Duct Smoke Detector
 - 4. 2 – Programmable Control Relays
 - 5. 2 – Manual Pull stations with “Stopper” Covers.
 - 6. 2 – Horn/Strobes, Adjustable
 - 7. 2 – Strobes, Adjustable

PART 3 - EXECUTION

3.1 Installation:

- A. Provide audible and visual devices as shown, located as per local codes.
- B. Connect audible and visual devices so all will sound and flash continuously until silenced when any alarm device is activated.
- C. Conceal all wiring in finished areas above ceiling where possible. Fire alarm Junction boxes shall be red and identified.
- D. Submit wiring diagram indicating color coding and wire sizes prior to installation. Furnish final wiring diagram after completion of system to Owner.
- E. Provide interlock wiring for HVAC units.
- F. Provide connections to all required air system fans to shut them down upon activation of a duct mounted smoke detector or HVAC shutdown switch. Provide

connections to the starter control circuit for motors with starters. Provide 1 HP motor rated relays for all 120 volt motors or motors without magnetic starters. Provide required interlock wiring to shut down all associated air conditioning compressors, heat pumps, electric duct heaters, and outside air intakes.

- G. The contractor shall meet with the fire Marshall and owner to coordinate programming of the addressable devices. Use actual room numbers and field descriptions agreed upon by all parties. Do not use construction blueprint room numbers.
- H. Where the contractor opts to have remote strobe power supplies, he shall be responsible to provide all required 120 volt power to the remote location. Use a dedicated circuit of dedicated fire alarm circuit with capacity.
- I. All wiring methods shall be in EMT or Red fire alarm MC cable and be installed in compliance with 16100 and as specified herein. (No MC cable shall be installed exposed).
- J. The contractor shall not **rough-in** or **order fire alarm equipment** until the fire alarm drawings are **approved** by the Fire Marshall.

3.2 Inspection, Test, Adjustment, and Report:

- A. Contractor shall furnish all necessary equipment and appliances for testing complete system during process of work and after completion of installation, including a meager test of all wiring. Tests generally shall demonstrate following to satisfaction of Owner:
 - 1. That all circuits are continuous and free from short circuits.
 - 2. That all circuits are free from unspecified grounds.
 - 3. That resistance to ground of all non-grounded circuits is not less than 1 megohm.
 - 4. That all circuits are properly connected in accordance with applicable wiring diagrams. Test of detector circuits shall be performed with all ionization, photoelectric and thermal type detectors removed from their bases.
- B. In addition to general tests listed above and prior to acceptance of project by Owner, an authorized factory trained representative shall inspect, test and adjust complete fire detection and alarm system. Inspection, tests and adjustments shall be made in presence of Contractor and Owner's representative and shall include following:
 - 1. Visual inspection of all equipment.
 - 2. Verification of fire and trouble alarm signals at all receiving locations and circuits, including audible and visual alarms, remote annunciators, etc.

Owner's personnel may be required for this verification.

3. Test of sensitivity of each ionization and photoelectric detector by means of test set.
 4. Examination of location of each detector to determine if effectiveness of a detector may be or has been reduced or if field conditions indicate requirements for relocation or addition of detectors.
- C. All detector adjustments and tests shall be performed as follows:
1. With detector in its exact operation location, not at a convenient test place.
 2. Under maximum air flow conditions, after air balancing has been performed, with supply air systems constant and no undergoing balancing or other alterations, and with air conditioning refrigeration and heating systems operating properly.
 3. On clean detectors.
- D. Any defects detected during general tests and complete system test shall be repaired as quickly as possible, and tests re-conducted.
- E. A fire and smoke detection system inspection and test report shall be completed and endorsed by a factory representative and placed on file with Owner. Report is mandatory; it shall include all test dates, detector locations, serial numbers and sensitivities. It shall contain a summary of all maintenance performed, all recommendations for relocation or addition of detectors, and final action regarding these recommendations, and shall contain a system certification.

3.3 Guarantee:

- A. Guarantee unconditionally as specified in the General Conditions, following acceptance by Owner, the complete Fire Alarm System. During this period, adjust, repair or replace, at no cost to Owner, any item of equipment, material or workmanship found to be defective.

(END OF SECTION)

SECTION 16745 - COMPUTER NETWORK SYSTEM

The general conditions, any supplementary General Conditions and Division 1, General Requirements, are hereby made a part of this section as fully as if repeated herein.

PART 1 - GENERAL:

1.1 Scope of Work:

- A. Work included: Enhanced Category 5e computer data cables, outlet, patch panel, and equipment rack.
- B. Computer system concentrators shall be furnished and installed by others.
- C. Provide test report indicating that the specified test have been performed and that the installation has met the requirements specified herein.

1.2 Codes and Standards:

- A. Local building code.
- B. Ethernet 100 Base-T, and T1A-568B installation standards.
- C. Installer must be factory certified with a 15 year manufacturers warranty.

1.3 Submittals:

- A. Provide a submittal booklet on all cables, jacks, patch panels, labels, and equipment racks.
- B. Include a copy of factory certification.

PART 2 - PRODUCTS

2.1 Materials:

- A. Conduits shall be 1" minimum and types shall be as described in 16100.
- B. Cables: All computer cables shall be plenum rated Category 5e Cable #24 AWG 4 twisted pair.
- C. Outlets: All outlets shall comply with Category 5e specifications and be approved for data transmission rates of 1000 mbs, F1A/T1A-568B. Wall plates are to be modular four port stainless steel face plate standard. Provide RJ-45 modular jack, category 5e, color as specified. Provide Leviton, Interlink, Molex, Amp, Hubbell or Ortronics.
- D. Patch Panel: Patch panels shall comply with Category 5e specifications and be approved for data transmission rates of 1000 mbs. Provide 48 port patch panels,

quantity as required to terminate all data outlets. The patch panel shall be labeled with the appropriate data connector identification number. Provide same manufacturer as the RJ-45 jacks.

- E. Equipment Racks: Equipment racks shall conform to EIA Standard RS-310C for 19 x 72 inch racks and shall be complete with all rack mounting hardware and ground bar. Racks shall be constructed of steel, capable of supporting up to 600 pounds and shall be open, with Type B universal mounting rail hole pattern. Racks shall be attached to the floor with appropriate sized lag screws.
- F. Uninterruptable Power Supply:
1. The Contractor shall provide and install a rack mounted UPS in each equipment rack as shown on the drawings.
 2. The UPS shall consist of:
 - a. Rack mounted power supply (APC Smart UPS, SU1400 RM).
 - b. DB-9 port and cable for RS-232 connection to file server.
 - c. Monitoring and control software for operation on the file server with Novell O/S.
 3. The Ups shall meet the following performance criteria:
 - a. Rated at 1400 VA and 950 watt output.
 - b. Input and output shall be 120 VAC, 60 Hz.
 - c. Four 15 amp output receptacles, minimum.
 - d. RFI/EMI line noise filtering.
 - e. Surge and Spike Protection (surge energy rating greater than 450 joules, response time <5 ns).
 - f. Voltage Sag and Brownout Protection (90 VAC corrected to 120 VAC).
 - g. 2 ms transfer time (typical).
 - h. Greater than 20 minutes back up time at half load.
 - i. 8 hour recharge time.
 - j. Does not require true sine wave output.
- G. Patch Cables:
1. Successful bidder shall supply patch cables for cross-connection of patch panels and network switches.
 2. The type of jumper cables shall depend on EIA./TIA Category 5 applications and the patch panel termination block or a LIU utilized.
 3. Patch cables shall be provided for each station data port wired throughout lengths shall be 10'.
 4. Provide patch cords with lengths of 50% 3', 50% 4' as required for the

installation. Provide a patch cord to connect each data hub switch to the patch panel.

PART 3 - EXECUTION

3.1 Installation

A. Cabling shall be installed in accordance with the following:

1. All cabling is to be installed with extreme care. Cables must not be cinched, subjected to sharp bends in excess of the manufacturer's recommended bending radius or anything else that would change the specified characteristics of the cable.
2. Cables run exposed above accessible ceilings shall be run in bundles of a size convenient to the contractor for easiest installation. Bundle by use of cable ties, taking care not to bend cables. Cable ties shall be supported by rings supported from roof structures, joists, and other structural members. In no case shall cable be supported from below by contact with the ceiling system. Maintain a distance of 12 inches from lighting fixtures and other electrical devices and conduit runs in the ceiling space.
3. Cable from work stations to wire closet are to be continuous, without splices.
4. Cables passing through walls shall be sleeved. Said sleeves shall be fireproofed to maintain the integrity of firewalls, smoke barriers and walls extending to the underside of the structure. Where wiring requirements exceed that of a single sleeve, multiple sleeves shall be installed in accordance with the following:

<u>Conduit Size</u>	<u>Maximum No. of Cables</u>
3/4"	2
1"	4
1 1/4"	8
1 1/2"	11
2"	18

5. A graphic representation of the patch panel with appropriate labeling is to be provided if space is not available on the actual patch panel itself. Contractor to provide a CNO connector identification number cross reference table if actual room numbers are different from those on network design drawings. Both of the above items should be permanently mounted and available in the wire closet.
6. All cabling shall be tagged with the cable identification number of both ends. Indicate compatible number at each outlet on a 1/8" scale the as-built computer plan.

3.2 Tests.

- A. Before the network wiring will be accepted as complete, the following must be demonstrated:
 - 1. Certification of wire pair suitability shall be performed with a time domain reflectometer (TDR), such as a MicroTest PentaScanner, to ensure the wire will correctly support a 100Mbps data rate.
 - 2. It shall be demonstrated that no appreciable AC or DC voltages are present on any pair.
 - 3. A continuity test shall be demonstrated on each pair from each end.
 - 4. The cable type, impedance, capacitance wire gauge and type requested in the contract shall be certified to be the same that was installed.
 - 5. No splices shall be made outside of the distribution room/patch panel.
- B. The above tests shall be incorporated into a report and submitted prior to acceptance of the project.

3.3 Guarantee:

- A. Guarantee unconditionally as set forth in the General Conditions following acceptance by Owner all work done under this section. During this period, adjust, repair or replace any item of equipment, material or workmanship found to be defective, at no cost to Owner.

(END OF SECTION)