

SECTION 16000
ELECTRICAL GENERAL PROVISIONS

PART 1 GENERAL

1.01 DESCRIPTION OF WORK:

- A. Work included in this Division consists of providing all demolition, labor, materials, equipment, tools, supervision, start-up services, Owner's instructions, including all incidental and related items necessary to complete installation, and successfully test, start up and operate building in a practical and efficient manner. Electrical Systems indicated on Drawings and described in each Section of Specifications Division 16 and conforming with all Contract Documents.
- B. Work not included under this Division:
 - 1. Low voltage temperature control wiring. Refer to Part 2, Paragraph 2.03 of this Section.
 - 2. Field painting of equipment, except for repair to damaged factory finishes.
- C. The General Provisions of this Contract, including General and Supplementary Conditions and other General Requirements Sections, apply to the Work specified in this Section.
- D. This Section is not intended to supersede, but to clarify, the definitions in Division 1, General Requirements and Supplementary Conditions.

1.02 DRAWINGS AND SPECIFICATIONS:

- A. Drawings are diagrammatic and indicate general arrangement of systems and work included in Contract, and shall serve only as design drawings, and not as working drawings, for general layout of various equipment and systems.
- B. Drawings and Specifications are intended to supplement each other, and all work specified or indicated in either shall be provided. Should drawings disagree in themselves or with Specifications, the better quality or greater quantity of work shall be provided.
- C. Drawings and Specifications are intended to include all work and materials necessary for completion of the work. Any incidental item of material, labor or detail required for the proper execution and completion of the work and omitted from either the drawings and specifications or both, but required by governing codes local regulations, trade practices, operational functions, and good workmanship, shall be provided as part of the Contract Work without extra charge, even though not specifically detailed or specified.

1.03 SITE AND PROJECT DOCUMENT EXAMINATION:

- A. Submission of a proposal is considered evidence the Contractor has visited site, examined Drawings and Specifications of all trades including Architectural, Structural and Mechanical, and fully informed himself with all project and site conditions, and is proficient, experienced and knowledgeable of all standards, codes, ordinances, permits and regulations which affect his respective trade, and that all costs are included in his proposal.
- B. The Electrical Contractor and/or Sub-Contractor shall insure all required permits, and assessments have been obtained prior to any work beginning. Contractor shall verify requirement to include privilege fees, plan review fees, and permits as part of his formal bid.
- C. The Pre-Bid Meeting is not mandatory for Electrical Contractors to bid this project, but is highly encouraged. This meeting will be at Kirtland Community College, Main Campus (10775 N. St. Helen Rd, Roscommon, MI) Student Center on Tuesday, June 16th, 2015 at 3:00pm.

1.04 STANDARDS, CODES AND PERMITS:

- A. Refer to Division 1, General Requirements and Supplementary Conditions.
- B. All work under Electrical Sections shall comply with latest edition of applicable standards and codes of the following, including local codes and variances:
 - 1. NECA - Standards for Installation
 - 2. NFPA - National Fire Protection Association
 - 3. NEC - Latest edition of NFPA 70
 - 4. UL - Underwriter's Laboratories

5. NEMA - National Electric Manufacturers Association
 6. NESC - National Electric Safety Code (H13)
 7. OSHA - Occupational Safety and Health Act
 8. IEEE - Institute of Electrical and Electronics Engineers
- C. All work shall be provided and tested in accordance with all applicable local, county, state laws, ordinances, code rules and regulations, including Michigan Department of Labor, General Rules, Part 8-Electrical Code Rules.
- D. No work shall be covered or enclosed until work is tested in accordance with applicable codes and regulations, and successful tests witnessed and approved by authorized inspection authority. Written approvals shall be secured by Contractor and submitted to Engineer before final acceptance of work.

1.05 SUBMITTALS:

- A. Proposal Supplement:
1. Contractor to submit one (1) copy of Proposal Supplement - SECTION 16010 - ELECTRICAL EQUIPMENT AND MATERIALS, at the time of Bid opening, listing the manufacturers upon which his bid was based, including all items being provided by Sub-Contractors.
 2. After Proposal Supplement and Sub-Contractors are approved, no deviation shall be permitted without written approval of Engineer.
- B. Shop Drawings:
1. Submit nine (9) copies of shop drawings on all equipment and materials indicated in the specifications or on drawings.
 2. At the time of submittal for review by the Engineer, shop drawings shall include signatures or stamps indicating that the Contractor and/or the Sub-Contractor has reviewed the submittals and has coordinated the required space, quantities required, services and work of other trades for the equipment or system being submitted.
 3. Submittals shall be in the form of bound folders with the name of the Project, Architect, Engineer and the submitting Contractor indicated on the cover. Submittals requiring drawings too large to be bound into the folder shall be folded and inserted in pockets bound into the folder.
 4. Submit complete manufacturer's shop drawings of all equipment, accessories and controls, including dimensions, weights, capacities, construction details, installation, controls, wiring diagrams, and motor data.
 5. Engineer's approval of show drawings is for general application only and is a service only and not considered as a guarantee of total compliance with or as relieving Contractor of basic responsibilities under all Contract Documents, and does not approve changes in quantities, time or cost.
 6. After approval, each Contractor is responsible to provide information to all other trades involved in, or affected by, installation of his equipment and work.
- C. Operating and Maintenance Instructions and Manuals:
1. Electrical Contractor shall provide for all items of equipment three (3) bound and indexed sets of operating/installation and maintenance instructions to Engineer for approval. After approval, manuals will be given to Owner by the Engineer.
 2. Manuals shall include a complete set of shop drawings submitted, indexed with tabs for each section.

1.06 ELECTRICAL SERVICE REQUIREMENTS:

- A. Permanent Electrical Service:
1. The Electrical Contractor is to verify with the Electrical Utility Company the electrical system amperage, voltage and phase and report any variations from what is indicated on the drawings to the Engineer. Electrical Contractor is to obtain written verification of the available symmetrical and asymmetrical RMS fault current from the Electrical Utility

- Company. Basis of design and bidding shall be a minimum of 100,000 system integrated A.I.C.on "MDP" overcurrent devices and branch circuit panelboard overcurrent devices.
2. The Electrical Contractor shall select the over current protection devices and coordinate with the fault current. Submit a list of the devices and how coordination will be achieved. This submittal shall be in the form of a shop drawing.
 3. Under the base bid, the Electrical Contractor shall furnish and install electrical conduits and conductors from main distribution panel to padmount transformer secondary terminals. Actual connection of wires to secondary terminals of transformer shall be done by the Electrical Utility Company.
 4. The Electrical Contractor shall also supply and install the concrete pad for the new pad-mount transformer. Coordinate the size and requirements with the Electrical Utility Company.
 5. Any costs from the Electrical Utility Company associated with bringing permanent power to the site shall be paid for by the Owner.

1.07 TEMPORARY ELECTRICAL SERVICE:

- A. Temporary Power shall be furnished to the site by the Construction Manager as described in Bid Scope. E.C. shall make appropriate arrangements with the Construction Manager and the Electrical Utility Company if additional electrical work is required onsite.
- B. Each Contractor shall be responsible for the safety of their respective cords and cables and shall be maintained in safe working order at all times.

PART 2 PRODUCTS

2.01 STANDARDS:

- A. All products shall be of established manufacturers regularly engaged in making type of materials to be provided and complete with all parts, accessories, trimmings, connections, etc. as specified in detail or as described in manufacturer's catalog.
- B. All material shall be labeled or listed by Underwriter's Laboratories, Inc. Assembled electrical equipment supplied to the job site shall be listed or labeled and/or approved by the authority having jurisdiction.

2.02 SUBSTITUTION AND CHANGES:

- A. Contractor and/or Equipment Supplier may propose alternate equipment or materials of EQUAL or better quality, function, performance, durability and appearance. This information is to be submitted to the Engineer's Office ten (10) working days prior to bid due date to allow for proper review time and to issue an addendum incorporating the acceptable substitution(s). It is the submitter's responsibility to provide sufficient material for review as required by Engineer's Office. Acceptance and approval is the responsibility of the Engineer.
- B. Contractor and/or Equipment Supplier is liable for any added costs to himself or others and is responsible for verifying dimensions, clearance and roughing-in requirements, when product not named as the basis of design are used and is responsible for advising other Contractors of variations and submit revised drawing layout for approval of Engineer.
- C. See Section 16010 for voluntary alternates.
 1. No substitutions will be accepted after bids are received. The lighting or electrical equipment specified herein has been carefully chosen for it's ability to meet the luminous performance and/or design criteria of this project. Substitutions in all likelihood will be unable to meet all of the same requirements as the specified equipment.
 2. When only one manufacturer is listed within the description of the luminaire or electrical equipment, the design engineering or architectural aesthetics will not allow substitution of other manufacturer.
 3. When two or more manufacturers are listed within the description of the luminaire or electrical equipment, the Contractor may elect to submit to the Engineer a substitute fixture for review. All submittals must follow paragraph 2.02.A of this section.

4. Substitution submittals shall consist of a physical description, dimensioned drawing and complete photometric and electric data of the proposed lamp, luminaire or electrical equipment. Working samples may be requested and shall be supplied to the Engineer for a visual check of finish and operating characteristics.
5. Contractor will be responsible for ALL costs (engineering time, manufacturer's costs, distributor costs, etc.) incurred to replace equipment not approved if substitutions are made by the distributor, manufacturer's rep., contractor or subcontractor.

2.03 EQUIPMENT REQUIREMENTS AND CONNECTIONS:

- A. Motor Starters and Controls:
 1. Electrical Contractor shall provide all manual or magnetic motor starters and combination motor starter disconnects as required for all motors as indicated on all Electrical Drawings.
 2. Mechanical Contractor shall provide factory installed motor starters integral with packaged equipment containing thermal overcurrent protection in all underground conductors with heater coils selected for specific motor usage for all motors.
- B. Electrical Wiring and Controls:
 1. Mechanical Contractor shall furnish and install all motors, drives, and controllers integral to equipment and factory-mounted controls for all mechanical equipment.
 2. Mechanical Contractor or Temperature Control Contractor shall furnish and install all electrical devices requiring mechanical connections, and/or electrical connections, such as pressure switches, limit switches, float switches, solenoid valves, motor operated valves, motor operated dampers, fire stats, freeze stats, thermostats, override timers, E.P.'s, P.E.'s, temperature control cabinet, air compressor with starter, etc.
 3. Temperature Control Contractor or Mechanical Contractor shall furnish and install all power and Class 2 and 3 wiring, conduit, boxes for their association equipment in 2.03, B, 2.
 4. Electrical Contractor shall install all power wiring, conduit to motors and/or factory mounted control panels as indicated on Electrical Drawings or as indicated in Specifications.
 5. All electrical wiring work by Mechanical Contractor and Temperature Control Contractor shall be in accordance with Specification Division 16 requirements.

PART 3 EXECUTION

3.01 COORDINATION OF ELECTRICAL WORK:

- A. The Electrical Contractor shall be responsible for all Sub-Contractors and Suppliers, and include in his bid all materials, labor and equipment involved in accordance with all local customs, rules, regulations, jurisdictional awards, decisions and secure compliance of all parts of the Specifications and Drawings regardless of Sectional inclusion in these Specifications.
- B. The Electrical Contractor and Sub-Contractor shall be responsible for all parts applicable to his trade in accordance with the Specifications and Drawings, and shall be responsible for coordinating locations and arrangements of his work with all other relevant Mechanical, Architectural, Structural and Electrical Contractor's Specifications, Drawings and Shop Drawings.

3.02 EQUIPMENT CLEARANCE:

- A. Electrical Contractor to coordinate with the Mechanical Contractor's equipment location to insure adequate clearance is maintained as required by the National Electrical Code and applicable state and local codes, as well as accessibility for future maintenance and operation.
- B. Electrical work shall be arranged with building construction to provide minimum 6'-8" overhead clearance where possible.

3.03 WALL, FLOOR AND CEILING OPENINGS:

- A. Locate all openings and advise the General Contractor of details and templates of all openings necessary for inspection of electrical work.

- B. In general, openings and required lintels shall be provided through the General Contractor. Size and location is the responsibility of this Contractor. Cracks and rough edges left following installation of equipment shall be caulked or covered by Electrical Contractor.
- C. Perform or pay for all cutting, fitting, repairing, patching and finishing of work of other sections where it is necessary to disturb such work to permit installation of electrical work.
 - 1. Repair or replace existing or new work disturbed.

3.04 FIELD CHANGES:

- A. The Contractor shall not make any field changes that affect timing, costs or performance without written approval from the Architect/Engineer in the form of a Change Order, Field Change Order or a Supplemental Instruction. The Contractor assumes liability for any additional costs for changes made without such instruction or approval. Should any unauthorized change be determined by the Architect/Engineer as lessening the value of the project, a credit will be determined and issued as a change to the Contract.

3.05 PROJECT CLOSEOUT:

- A. Final Acceptance and payment will only be made after final punchlist completion and receipt at the Engineer's Office of:
 - 1. All Guarantees/Warranties
 - 2. Operating and Maintenance Instruction Manuals
 - 3. Record Drawings (As Built)
 - 4. Certificates of Inspection
 - 5. Test Reports
 - 6. Lamps and ballasts.

3.06 CERTIFICATES OF INSPECTION AND TEST REPORTS:

- A. Submit to the Engineer's Office evidence that installation has been inspected and approved by local or state electrical inspector and/or the authority having jurisdiction.

3.07 GUARANTEES AND WARRANTIES:

- A. At the end of a one year period of continuous operation, make a complete inspection of all systems, fixtures, equipment, safety devices and controls to insure equipment is operating properly, and report to Engineer in writing.

3.08 RECORD DRAWINGS:

- A. Maintain a white-print set of Electrical Contract Drawings in clean, undamaged condition for markup of actual installation on Electrical Contract Drawings which vary substantially from the work as shown. These drawings are to be available for inspection by the Engineer on a weekly basis. Drawings shall indicate at a minimum the routing of all conduits over 2" on size, revised circuiting, revised panel schedules, emergency lighting controller (EPCs, BLTCs, etc.) locations, and addendum, bulletin and field changes.

3.09 OPERATING AND MAINTENANCE INSTRUCTIONS:

- A. Provide instruction of Owner's personnel in operation and maintenance procedures for all systems equipment.
- B. Provide 3 - bound & tabbed sets of operating & maintenance instruction manuals for all electrical equipment

3.10 PLACING SYSTEMS INTO OPERATION:

- A. Electrical Contractor shall be responsible for all startup procedures, system checks and balancing associated with his equipment.
- B. All equipment shall be installed, tested and operated in accordance with manufacturer's recommendations at normal operating conditions.
- C. All permanent electrical equipment operated during construction periods shall be cleaned and damaged equipment replaced.

3.11 ADJUSTMENTS AND BALANCING:

- A. Contractor shall make all necessary adjustments to equipment installed or connected by him under this contract so as to insure proper operation of the same.
- B. PROVIDE WRITTEN VERIFICATION TO NEALIS ENGINEERING, INC. OF TEST DATA ON ALL TRANSFORMERS AND PANELS. TEST DATA SHALL INCLUDE VOLTAGE AND AMPERAGE.

3.12 GUARANTEES AND WARRANTIES:

- A. All labor, materials and equipment shall be guaranteed by Contractor and/or warranted by Manufacturer for one year after acceptance date and/or one normal continuous complete season of operation applicable to equipment or system except where specified longer for special equipment. Contractor shall secure such warranty from all Suppliers (not one year from shipment date), or Contractor to assume warranty.
- B. Acceptance date of substantial completion shall be Owner occupancy as determined by Architect/Engineer.
- C. Contractor shall make all necessary alterations, repairs, adjustments, or replacements during guarantee periods as directed by Architect/Engineer to comply with Drawings and Specifications at no cost to Owner.
- D. Repair or replacements made under guarantee bear further one year guarantee from date of acceptance of repair or replacement.

3.13 IDENTIFICATION:

- A. All service switches, motor disconnects, controllers, etc., whether or not furnished under this Division shall be marked to identify the equipment served and the origin of the power source. Distribution panels, branch panels and switchboards shall be identified as to the designation indication on the Contract Drawings and voltage characteristics. Individual switches in Distribution Panels and Switchboards shall be identified as to equipment being fed.
- B. All identification shall be done with engraved 5-ply lamacoid plates with ¼" white lettering on a black background or black lettering on a white background. "Dymo" or tape markers ARE NOT acceptable.
- C. Concisely and clearly type out all branch panel schedules indicating room or area served along with the item(s) connected to each circuit.
- D. See Electrical Drawing Detail for additional identification requirements.

3.14 TRAINING:

- A. The option of videotaping any and all training sessions shall be given to the Owner at no additional cost, with the Contractor conducting the videotaping and with two (2) copies of all tapes being turned over to the Owner for future use.
- B. E.C. shall conduct 1 - 4 hour training session on the operation and controls of all electrical equipment. Notify owner 72 hours prior to session.
- C. E.C. shall conduct 2 - 2 hr training sessions on the operation & control of the Fire Alarm System. Notify owner 72 hours prior to session.
- D. E. C. shall conduct 2 - 2 hr. training session on the operation & control of the lighting control systems, which includes the occupancy sensors, the over-ride switches, and the lighting control panels. Notify owner 72 hours prior to session.

END OF SECTION

SECTION 16010
ELECTRICAL EQUIPMENT AND MATERIALS

PART 1 GENERAL

1.01 INSTRUCTION:

- A. The Electrical Contractor is to either copy or remove this specification section from the spec book and complete as follows:
 - 1. Indicate the specific manufacturer on which the bidder's base bid price is based in the blank space provided.
 - 2. All equipment is to be bid as specified. Material or equipment from another manufacturer may be bid as a Voluntary Alternate, but the dollar amount must be shown as an "Add" or "Deduct" to the base bid. Provide the name of the alternate manufacturer in the space provided.
 - 3. Insert the name(s) of each subcontractor used in your bid in the space provided in Part 3.
 - 4. This form shall be submitted with the bid.

1.02 RELATED DOCUMENTS:

- A. The other Contract Documents complement the requirements of this Section. The General Requirements apply to the work of this section.

1.03 DEVIATIONS FROM SPECIFIED MATERIAL:

- A. See Section 16 00 00, Part 2, Paragraph 2.02 - Substitutions and Changes. Base bid shall be based on manufacturers listed in this specification or on the drawings.

PART 2 PRODUCTS

2.01 THE FOLLOWING IS A LIST OF APPROVED MANUFACTURERS, GROUPED ACCORDING TO TYPES OF MATERIALS OR EQUIPMENT.

- A. Wiring Devices:
 - 1. Pass & Seymour, Hubbell, Leviton, and Cooper
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____
- B. Surface Raceway (including Plug Strip):
 - 1. Wiremold and Panduit
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____
- C. Cable Tray:
 - 1. Legrand Wiremold, Mono-Systems, Thomas & Betts, and B-Line
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____
- D. Floorboxes and Underfloor Raceways:
 - 1. Hubbell, Wiremold, MonoSystems, and Thomas&Betts
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____
- E. Electric Hand Dryers:
 - 1. Dyson, World, and Excel
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____
- F. Electric Heater:
 - 1. Berko, Broan, and King
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____

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- G. Electric Fireplace:
 - 1. Dimplex
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____
- H. Generator:
 - 1. Generac Industrial, Cummins, Caterpillar, and Kohler
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____
- I. Automatic Transfer Switch
 - 1. Generac, Cummins, Caterpillar, Kohler, ASCO, and Russ Electric
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____
- J. Switchboard & Distribution Panels:
 - 1. Square D and Siemens
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____
- K. Branch Panels:
 - 1. Square D and Siemens
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____
- L. Safety Switches:
 - 1. Square D and Siemens
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____
- M. Motor Controls:
 - 1. Square D and Siemens
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____
- N. Dry Type and/or Buck/Boost Transformers:
 - 1. Square D and Siemens
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____
- O. Surge Protection Devices
 - 1. Liebert
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____
- P. Fire Alarm & Mass Notification System
 - 1. Simplex
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____
- Q. Voice Communication Pedestal
 - 1. Talk-a-Phone or Code Blue
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____
- R. Central Clock System
 - 1. Dukane
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____

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- S. Occupancy Sensor Lighting Control
 - 1. Leviton, WattStopper, HBA, or Sensor Switch
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____

- T. Lighting Control Relay Panel
 - 1. Leviton, LC&D, HBA, or Cooper
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____

- U. Lighting Controls - Dimming Systems
 - 1. Cooper, Crestron, HBA, Leviton, or Lutron
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____

- V. Lighting Fixtures:
 - 1. Tag A, A1, A2, A3: Cooper
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
 - 2. Tag B, B2: Cooper
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
 - 3. Tag C, C2, and C3: Cooper Portfolio, Lightolier, Gotham, Focal Point, Wila Lighting, and Cree
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
 - 4. Tag C1 and C4: Cooper, Lithonia, Juno, Hubbell, and Lightolier
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
 - 5. Tag D4, D4E, D8, D8E: Lithonia, Cooper, Hubbell, and Lightolier
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
 - 6. Tag EX, EX1, EX2: Lithonia, Cooper, Hubbell, Isolite, and Dual-Lites
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
 - 7. Tag F, F1, F2, F8: Cooper
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
 - 8. Tag F3: Fluxwerx
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
 - 9. Tag G1: SPI
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
 - 10. Tag H: Amico
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
 - 11. Tag J: Bega
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
 - 12. Tag K: Lithonia, Cooper, Hubbell, and Lightolier
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
 - 13. Tag K2, K4: Lithonia, Cooper, Hubbell, Lightolier, and Axis Lighting
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
 - 14. Tag L, L1: Luminii
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
 - 15. Tag M: SPI
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
 - 16. Tag N: Lithonia, Cooper, and Lighting Science
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
 - 17. Tag OR1: Provided by Owner.
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
 - 18. Tag P1: Bruck, ConTech, and Tech Lighting
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____

- 19. Tag P2: Bruck, ConTech, and Tech Lighting
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
- 20. Tag P3: Bruck, ConTech, Tech Lighting, and Wila Lighting
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
- 21. Tag P4: Bruck, ConTech, Tech Lighting, and Wila Lighting
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
- 22. Tag R1: TLI and Lithonia
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
- 23. Tag T11, T12, T14, T20, T24: Lithonia, Cooper, Juno, Hubbell, Juno, and Lightolier
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
- 24. Tag TH1, TH2: Lithonia, Cooper, Juno, Hubbell, Juno, and Lightolier
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
- 25. Tag TP1: Bruck, ConTech, Tech Lighting, and Wila Lighting
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
- 26. Tag U/C3: Bruck, Juno, Tech Lighting, and Lightolier
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
- 27. Tag V: Lithonia, Cooper, Hubbell, and Lightolier
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
- 28. Tag AA: Bega
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
- 29. Tag BB: Lithonia, Cooper, Hubbell, and Ligholier
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
- 30. Tag CC: Cooper Portfolio, Calculite, Gotham, Focal Point, and Wila Lighting
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
- 31. Tag DD: Bega
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
- 32. Tag FF1, FF2: Invue
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____
- 33. Tag SL1, SL2, SL3, SL4, SL5: Lithonia, Cooper, Hubbell, and Lightolier
 - a. Voluntary alternate _____ Add \$ _____ Deduct \$ _____

PART 3 SUBCONTRACTORS

3.01 INSERT THE NAME OF EACH SUBCONTRACTOR AND WORK TO BE PERFORMED BELOW:

- A. Subcontractor _____
 Work Performed _____
- B. Subcontractor _____
 Work Performed _____
- C. Subcontractor _____
 Work Performed _____

PART 4 BID ALTERNATES

4.01 ALTERNATE NO. E-1:

- A. Description: Provide generator #2 and associated automatic transfer switch ATS#1 and accessories. Include all associated electrical feeder and branch circuits as noted per the Electrical Riser Diagram and Panel Schedules. Take note, include all underground conduits shown between generator #2 and Emergency Distribution Panel #EDP-1, in base bid. Also, include a wall mounted electrical junction box in Mechanical Room 126 as a temporary placeholder for future ATS #1. See Electrical Riser Diagram on drawing sheet E9 for more details. Refer to Section 11 in the Advertisements for Bids Document.

4.02 ALTERNATE ADD NO. E-2:

- A. Description: Provide generator #3 and associated automatic transfer switch ATS#2 and accessories. Include all associated electrical feeder and branch circuits as noted per the Electrical Riser Diagram and Panel Schedules. Take note, include all underground conduits shown between generator #3 and Emergency Distribution Panel #EDP-1, in base bid. Also, include a wall mounted electrical junction box in Mechanical Room 126 as a temporary placeholder for future ATS #2. See Electrical Riser Diagram on drawing sheet E9 for more details. Refer to Section 11 in the Advertisements for Bids Document.

4.03 ALTERNATE ADD NO. E-3:

- A. Description: Add five (5) Type-BB light fixtures, and associated branch circuit connections that are to be mounted within metal pergola in the landscape plaza. Refer to Section 11 in the Advertisements for Bids Document.

END OF SECTION

SECTION 16050
BASIC MATERIALS AND METHODS

PART 1 GENERAL

1.01 MATERIALS:

- A. All materials and equipment furnished for installation on this project shall be new and in strict accordance with Contract Documents. All packaged materials shall be delivered in their original containers which shall show the manufacturer's name and the identifying designations as to size, quality, etc. Materials delivered to the project unmarked or mutilated packages will be ordered to be removed from the site at once. Materials or equipment judged as "damaged" by the Architect/Engineer shall be removed from the project and site.
- B. Should any dispute arise to the quality of any material, the decision shall rest entirely with the Architect/Engineer and shall be based on the requirement that all materials furnished shall be first class in every respect, and what is usual or customary in erecting other buildings shall in no way enter into the consideration or decision whatever as it pertains to the project under consideration.
- C. All materials and equipment furnished under work of all Division 16 sections shall be UL approved and listed, and shall bear the Underwriter's Label.

1.02 SUBMITTALS:

- A. Submit shop drawings for the following: (See 16000 1.05 B 1 thru 6)
 - 1. Wiring devices.
 - 2. Floor Boxes.
 - 3. Surface Mounted Raceways (including plug strips).
 - 4. Boiler Emergency Shut-off.
 - 5. Cable Tray.
 - 6. Motor starters/contactors.
 - 7. Branch circuit panelboards.
 - 8. Distribution panelboards.
 - 9. Switchgear
 - 10. Safety switches / breakers.
 - 11. Generators.
 - 12. Automatic Transfer Switches.
 - 13. Surge Protective Devices.
 - 14. Indoor and outdoor light fixtures (See 16510 1.03 A thru D).
 - 15. Light Fixture Lamps.
 - 16. Lighting Controls, including dimmer switches, dimming systems, room controllers, lighting control panelboards, and vacancy/occupancy sensors.
 - 17. Electric Hand Dryers.
 - 18. Fire Alarm and Mass Notification System.
 - 19. Voice Communication Pedestals
 - 20. Clock System.
 - 21. Electric Heaters
 - 22. Electric Fireplaces

PART 2 PRODUCTS

2.01 RACEWAYS:

- A. Aluminum conduit is not acceptable in this Contract.
- B. Rigid Metal Conduit:
 - 1. Rigid metal conduit shall be hot dipped galvanized steel, meeting Federal Standard WW-C-581.
 - 2. Threaded fittings shall be used on rigid metal conduit.

- C. Electric Metallic Tubing:
 - 1. Electrical metallic tubing shall be standard weight, meeting Federal Standard WW- C-563 and bear the manufacturer's name and Underwriter's Label on each length. Maximum permissible size tubing shall be 4".
 - 2. Provide compression-type steel fittings or set screw-type steel fittings. Crimp-type connectors are not acceptable.
- D. Flexible Metal Conduit:
 - 1. Flexible metallic conduit shall meet Federal Standard WW-C-566 and is to have separate grounding conductor. Minimum permissible size shall be 1/2".
 - 2. Fittings shall be malleable iron, threaded type.
- E. Liquid-Tight Flexible Metal Conduit:
 - 1. Liquid-tight flexible metal conduit shall be single strip, flexible, continuous, interlocked, and double-wrapped steel. It shall be galvanized inside and outside, with a liquid-tight jacket of flexible polyvinyl chloride (PVC). Minimum permissible size shall be 1/2".
 - 2. Connectors shall be insulated throat, malleable iron.
- F. Liquid-Tight Flexible Non-Metallic Conduit:
 - 1. Liquid-tight flexible non-metallic conduit shall be single strip, flexible polyvinyl chloride (PVC). Minimum permissible size shall be 1/2".
 - 2. Connectors shall be non-metallic (PVC) compression type UL labeled and listed to be used on liquid-tight flexible non-metallic conduit.
- G. Rigid Non-Metallic Conduit:
 - 1. Rigid non-metallic conduit (PVC) shall be Schedule 40, rigid heavy wall polyvinyl chloride, 90 degrees C., UL rated.
 - 2. Fittings shall be solvent weld type of the same material as the conduit.
 - 3. All 45 degree bends or greater shall be made with rigid metal conduit fittings.
- H. Surface Metal Raceways:
 - 1. Exposed raceways noted on drawings as "Wiremold" shall be equal to Wiremold Series 5400 or as shown on drawings. Provide required anchors, fittings and outlet boxes as required. Outlet boxes shall be Wiremold #5748 or as shown on drawings.
- I. Wireways:
 - 1. Wireways shall be lay-in type and shall be UL listed as a wireway or auxiliary gutter. It shall be constructed with a hinged cover and knockouts. It shall be primed with a corrosion resistant primer and gray epoxy finish.
 - 2. Install raceways in a neat and workmanlike manner in accordance with NECA 1.
 - 3. Install raceways plumb and level.
- J. Cable Trays:
 - 1. Specifications and drawings are for assistance and guidance, but exact routing, locations, distances and levels will be governed by actual field conditions. Contractor is directed to make field surveys as part of his work prior to submitting system layout drawings.
 - 2. Cable tray shall be of uniform quality and appearance and be aluminum.
 - 3. Install wire basket cable tray in accordance with NEMA VE 2 to ensure that the cable tray equipment complies with the requirements of the NEC, applicable portions of NFPA 70B, and the National Electrical Contractors Association's (NECA) 'Guide to Quality Electrical Installations' pertaining to general electrical installations practices.
 - 4. All trays should be supported using a minimum of 1/4" All Threaded Rod (ATR).
 - 5. Provide sufficient space encompassing wire basket cable tray to permit access for installing and maintaining cables on a minimum one side.
 - 6. All cable tray installed above accessible ceilings shall be wire ladder type.
 - 7. All cable tray installed in visible exposed areas or installed within the second floor, shall have a ventilated corrugated trough and painted to match adjacent building surfaces.
 - 8. Cable trays shall be aluminum with a minimum 6" sides.

9. All routing of cable tray shall be coordinated with all other trades in the field prior to installation. Notify the Architect/Engineer if any routing conflicts are found.
 10. Install firestopping in accordance with local and NFPA regulations to sustain ratings when passing cable tray through fire-rated elements.
 11. Cable Installation:
 - a. Comply with cable installation requirements of NEMA VE 2.
 - b. Use appropriate cable pulling tools, applied to prevent excessive force on cable tray system and maintain minimum cable bending radius.
 12. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
 13. Unless otherwise indicated, arrange cable tray to be parallel or perpendicular to building lines
- K. Metal-Clad Cable:
1. Metal-clad cable shall be U.L. labeled and have a smooth, weld or corrugated metallic sheath. Type MC cable shall provide an adequate path for equipment grounding as required by N.E.C.

2.02 WIRE AND CABLE:

- A. All wiring shall be copper and shall be installed in conduit or tubing unless specified otherwise.
- B. All wire shall be new and in the original cartons or on manufacturer's shipping reels.
- C. No wire smaller than #14 may be used unless specified under descriptions of special systems. Wire #14 and larger shall be stranded.
- D. All branch circuit wiring shall be color coded black, red, blue, phases and white neutral for 120/208v, 3 phase, 4 wire system. All grounding / bonding conductors shall be green or bare. Phase color consistent throughout the entire branch circuit system.
- E. All neutral runs including feeders shall be white full length of conductor or identified per NEC.
- F. Select from the following wire types to comply with the project's installation requirements and NEC standards.
 1. Type THHN/THWN rated installation. 600 volt, 90 degrees C., in conduit, stranded copper, size No. 14 AWG up to and including No. 10 AWG.
 2. Type THWN-2 rated insulation, 600 volt, 90 degrees C., in conduit, stranded copper, size No. 8 AWG up to No. 750 MCM AWG.
- G. Select from the following cable types to comply with the project's installation requirements and NEC standards.
 1. Metal-Clad Cable: Type MC. Use in existing concealed locations only. (above ceilings, in walls etc.). Not to be used in exposed locations in areas other than mechanical or janitor closet type locations (unless otherwise approved prior to installation). Maximum length of twenty-five feet.
 2. Armored Cable: Type AC. Use in concealed location only. (above ceilings, in walls etc.). Not to be used in exposed locations in areas other than mechanical or janitor closet type locations (unless otherwise approved prior to installation). Maximum length of twenty-five feet.

2.03 WIRE CONNECTORS AND JOINTS:

- A. All conductors #8 AWG and smaller shall be joined with electrical spring connectors with vinyl insulating cap. Conductors larger than #8 shall be joined by compression type connectors.

2.04 OUTLET BOXES:

- A. Ceiling outlet boxes shall be 4" octagon, 2 1/8" deep, with fixture hickey, and supported to withstand 50 pounds.

- B. Convenience outlet and switch boxes shall be a minimum 4"sq. x 2 1/8" deep with 1 or 2 gang, 2" deep plaster ring. When installed in poured walls, 3 1/8" minimum deep masonry box shall be used; when installed in masonry blocks, minimum 4"sq. x 2 1/8" deep with 1 or 2 gang, 2" deep plaster ring shall be used.
- C. Floor outlet boxes shall be as shown on plans.
- D. Reference Electrical Drawings legends and details for more information on specific outlet boxes shown to be used in special applications.

2.05 JUNCTION BOXES AND PULL BOXES:

- A. When used, pull boxes and junction boxes shall be galvanized and have flat steel covers fastened with screws and set flush with the finished surface and located in an accessible area. When installed in damp locations, gaskets and seals shall be provided. Junction boxes shall be sized to meet N.E.C. Standards based on conduit and conductors. Provide identifying labels on each box.

2.06 WIRING DEVICES:

- A. Receptacles:
 - 1. Receptacles shall be specification grade. All devices shall be WHITE unless shown differently on plans or noted during shop drawing review.
 - a. 20 Amp, 125 Volt, duplex, ground fault, weatherproof (NEMA 5-20R).
 - b. 20 Amp, 125 Volt, duplex, ground fault (NEMA 5-20R).
 - c. 20 Amp, 125 Volt, duplex (NEMA 5-20R).
 - d. 30 Amp, 125/250 Volt (NEMA 14-30R).
 - e. 50 Amp, 125/250 Volt (NEMA 14-50R).
 - 2. See sheet E6 for more details and catalog numbers.
- B. Plug Strips (Plugmold):
 - 1. Plug strips shall be Wiremold with 15 or 20 amp, 125 receptacles on 12" centers. Provide all required fittings. See plan for lengths and further details.
- C. Wall Switches (Snap Switches):
 - 1. Switches shall be specification grade, totally enclosed molded composition, silent type, spring action silver contacts, and rated 120/277 volts A.C. All switches shall be binding screw type.
 - 2. Switches shall be rated at 20 Amp.
 - 3. Switches shall be WHITE for all locations, unless noted during shop drawing review.
 - 4. See sheet E6 for more details and catalog numbers
- D. Device Plates:
 - 1. Plates shall be brushed smooth stainless steel, except plates used on surface mounted boxes. Surface mounted outlets plates shall be raised, pressed metal type. Mounting screws shall be metal with same finish as plate and with countersunk head. Plates shall be single ganged, or combination, to accommodate arrangement indicated on drawings.
 - 2. Floor outlet cover plates shall be for power, telephone and/or data outlets as required. Provide polycarbonate carpet flanges in all carpeted areas. Floor boxes if used on second floor shall be U.L. labeled as poke-through fire rated boxes.
- E. Electric Hand Dryers:
 - 1. Hand Dryers shall be surface mount, automatic activation, 120V, 12 amps, 1500 watts maximum, 60 hertz, stainless or gray in color.
 - 2. Electric Hand Dryer (EHD-1) shall be equal to Dyson Airblade #AB14-301853-01.
 - 3. Electric Hand Dryer (EHD-2) shall be equal to World #K-973.

2.07 MOTOR CONTROLLERS:

- A. 120 volt, less than 1/4hp:
 - 1. Provide motor toggle switch with heater, pilot light and lockout guard. Mount adjacent to motor. Size heater per NEC and manufacturer's recommendations. Based on Sq-D #FGJ5P (surface mount) or # FF2P FL2 (flush mount).
- B. 120 volt, 1/3hp to 1hp:
 - 1. Provide NEMA rated combination magnetic motor starter and disconnect in appropriate enclosure with H.O.A. selector switch, red pilot light, 1 - N.O. & 1 - N.C. Aux. coil. Combination motor starter disconnect shall be Sq-D Class 8539 with breaker sized for respective motor load or two speed starters as shown on plans. Mount within sight and within 50' of motor. Size heaters per NEC and manufacturer's recommendations.
- C. 208v, 1ph, less than 1 hp:
 - 1. Provide motor toggle switch with heater, pilot light and lockout guard. Mount adjacent to motor. Size heater per NEC and manufacturer's recommendations. Based on Sq-D #FGJ6P (surface mount) or #FF1P FL1 (flush mount).
- D. 208v, 1ph; 208v, 3ph; 480v. 1ph; and 480v, 3ph; 1/2hp or larger:
 - 1. Provide NEMA rated combination magnetic motor starter and disconnect in appropriate enclosure with H.O.A. selector switch, red pilot light, 120 volt control transformer, 1 - N.O. & 1 - N.C. Aux. coil. Combination motor starter disconnect shall be based on Sq-D Class 8539 with breaker sized for respective motor load or two speed starters as shown on plans. Mount within sight and within 50' of motor. Size heaters per NEC and manufacturer's recommendations.

2.08 SWITCHBOARDS

- A. Service Entrance Switchboards:
 - 1. Listed and labeled as suitable for use as service equipment according to UL 869A.
 - 2. For solidly-grounded wye systems, provide factory-installed main bonding jumper between neutral and ground busses, and removable neutral disconnecting link for testing purposes.
 - 3. Comply with Utility Company requirements for electrical service.
- B. Short Circuit Current Rating:
 - 1. Provide switchboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
- C. Future Provisions:
 - 1. Prepare designated spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
- D. Pull Section:
 - 1. Arrange with pull section on left side of switchboard as viewed from the front.
- E. Enclosure: Type 1 - General Purpose.
 - 1. Switchboard Height: 92 inches (2336.8 mm), excluding floor sills, lifting members and pull boxes.
 - 2. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.
- F. Circuit Breakers:
 - 1. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.

- G. Molded Case Circuit Breakers:
 - 1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
 - 2. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - 3. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
- H. Before energizing switchboard, perform insulation resistance testing in accordance with NECA 400 and NEMA PB 2.1.
- I. Inspect and test in accordance with NETA ATS, except Section 4.
- J. Perform inspections and tests listed in NETA ATS, Section 7.1.
- K. Molded Case and Insulated Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers. Tests listed as optional are not required.
- L. Clean dirt and debris from switchboard enclosures and components according to manufacturer's instructions.
- M. Repair scratched or marred surfaces to match original factory finish.
- N. Reference Standards:
 - 1. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
 - 2. NECA 400 - Standard for Installing and Maintaining Switchboards; National Electrical Contractors Association; 2007.

2.09 DISTRIBUTION PANELBOARDS & METERING EQUIPMENT:

- A. Distribution and metering equipment shall be of the circuit breaker type with main lugs or main switch as indicated on drawings rated at 250 volts or 600 volt maximum, 3 phase, 4wire AC, respectively, capable of withstanding available fault current and be U.L.S.E. labeled and listed, surface mount, bottom fed. Circuit breakers shall be system series rated.
- B. Main distribution and power panelboards shall be based on Square "D" breaker type I-Line meeting Federal Specification W-P-115A. Switches shall be Sq-D breaker type to fit panelboard.
- C. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
- D. Metering Transformers
 - 1. Current Transformers: IEEE C57.13, 5 ampere secondary, wound type, with single secondary winding and secondary shorting device, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.
 - 2. Potential Transformers: IEEE C57.13, 120 volt single secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.
 - 3. Include the PM8ECC Ethernet communications card option.
 - 4. Manufacturers: based on Square D Basic Power Logic panel mounted or remote mounted unit. Supply with potential and current transformers.
- E. Reference Standards:
 - 1. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
 - 2. NECA 407 - Standard for Installing and Maintaining Panelboards; National Electrical Contractors Association; 2009.

2.10 BRANCH CIRCUIT PANELBOARDS:

- A. Branch circuit panelboards shall be of the circuit breaker type with main lugs or main switch as indicated on drawings rated at 120/208 volts maximum, 3 phase, 4 wire AC capable of withstanding available fault current and be U.L. labeled and listed, surface or flush mounted, bottom or top fed with ground bar kits. Circuit breakers shall be system series rated. Panelboards shall be based on Square "D" type NQ.
- B. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
- C. Provide the following circuit breaker types where indicated:
 - 1. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
 - 2. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
 - 3. 100 Percent Rated Circuit Breakers: Listed for application within the panelboard where installed at 100 percent of the continuous current rating.
 - 4. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
- D. Do not use tandem circuit breakers.
- E. Do not use handle ties in lieu of multi-pole circuit breakers.
- F. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.
- G. Interrupting Capacity:
 - 1. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than: 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
- H. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
- I. Reference Standards:
 - 1. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
 - 2. NECA 407 - Standard for Installing and Maintaining Panelboards; National Electrical Contractors Association; 2009.

2.11 FUSES:

- A. Fuses 600 Amperes and Less: Dual element, current limiting, time delay, one-time fuse, 250 or 600 volt, UL Class J. Supply Owner with 3 - spare fuses of each size if applicable.
- B. Fuses 601 Amperes and Larger: Current limiting, fast-acting, one time fuse, 600 volt, UL Class L. Supply Owner with 1 - spare fuse of each size if applicable.
- C. Interrupting Rating: 200,000 rms amperes.

2.12 SAFETY SWITCHES:

- A. Furnish and install all required safety switches.
- B. Safety switches shall be NEMA heavy duty type "HD", fusible or non-fusible as shown on drawings and be U.L. labeled and listed. Switches shall be furnished in NEMA-1 general purpose dry location enclosures unless otherwise shown on drawings. Weatherproof switches shall be NEMA-3R (raintight).
- C. Switches shall be horsepower rated with interlocking provisions to prevent unauthorized opening of the switch covers in the "ON" position. Switches shall be capable of being physically locked in the open (off) position.
- D. Switches shall be Sq-D type "HD" 250v or 600v, respectively.

PART 3 EXECUTION

3.01 RACEWAYS:

- A. Conduit or tubing shall be installed in a manner which complies with all applicable provisions of the National Electrical Code and at least six inches from parallel runs of steam pipes, flues, or hot water pipes.
- B. Ends of all conduit or tubing shall terminate in a bushing or fitting having factory installed insulating liners. Provide plastic bushings on all conduit or tubing with wire larger than #4 AWG. Exposed runs shall be supported by hangers, clamps, or straps secured by toggle bolts in hollow construction or expansion bolts or inserts in poured or brick walls. No lead anchors shall be allowed
- C. Every precaution shall be taken to protect the conduit from damage and from water, dirt, concrete, etc., getting into the system during construction. Capped bushings shall be used on all conduit terminations until wire is installed. If, in the opinion of the Engineer, conduit or tubing has become damaged or contains unremovable foreign matter, it shall be replaced at the Contractor's expense.
- D. Rigid metal conduit shall be used in all poured construction, fill, outside masonry walls, areas exposed to weather, under drives and walks, and in areas where tubing may become damaged..
- E. Rigid non-metallic conduit (PVC) may be used in lieu of rigid metal conduit below grade or where concealed in concrete. Provide a separate bare stranded copper grounding conductor in the raceway sized in accordance with Table 250.122 of the NEC.
- F. Electrical metallic conduit (EMT) shall be used for feeders and branch circuits above ground & above suspended accessible ceilings; for switch and receptacle legs which terminate above suspended accessible ceilings; for exposed feeders and branch circuits; for switch legs in moveable partitions.
- G. Flexible metal conduit shall be used for connections to the following equipment: lighting fixtures only. Maximum length of flexible metallic conduit shall be 6'-0". Longer length may be permitted at the discretion of the Owner or as indicated on the plans. Minimum size shall be ½". Flexible metal conduit used for lighting fixture connections shall be "Greenfield" type. Fittings shall be insulated throat, flex-steel connectors.
- H. Use liquid-tight flexible steel conduit and liquid-tight flexible non-metallic conduit for final connections to all indoor and outdoor motors and mechanical equipment with a length not to exceed 36".
- I. Surface metal raceways (Wiremold) shall be installed where indicated on the drawings. The Architect/Engineer shall approve all routing and color of Wiremold prior to installation.
- J. At all wall penetrations, space around circuits shall be filled with mortar or other approved filler. Penetrations through walls, floors or ceilings must not alter the fire rating of the assembly.
- K. Install from each recessed branch panel, four (4) 1" conduits to the nearest accessible ceiling space for future branch wiring. Identify such conduits above the ceiling.
- L. Mount floor-mounted power distribution panelboards or switchgear on properly sized 4 inch (80 mm) high concrete pad.
- M. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- N. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches (2000 mm) above the floor or working platform.
- O. Provide filler plates to cover unused spaces in panelboards.
- P. All conduit and boxes shall be flush mounted and concealed. No exposed conduit will be allowed, except in electrical and mechanical spaces, and where specifically noted.

3.02 WIRE AND CABLE:

- A. All wiring shall be installed in approved raceways. Conductors shall be continuous between outlets or junction boxes with splice made only within such boxes.
- B. Any branch circuits over 50 feet in length shall be installed with one wire size larger than the circuit rating. Example: 1P/20amp breaker with #12 THHN wire run 50'+ shall be increased to a #10 THHN wire.

3.03 OUTLET BOXES:

- A. Set boxes squarely with faces flush to finished surfaces. The exact location of all outlets shall be approved by the Architect/Engineer before same are place and Contractor shall consult Architect/Engineer at all times relative to the location of outlets. No outlets shall be placed behind plumbing or heating pipes or where they will interfere with ducts, pipes, equipment, or other work.
- B. Each outlet shall be rigidly supported from the building construction (independent of the raceway system).
- C. CAUTION!! All outlet boxes shown within precast concrete walls shall pre-coordinated with Construction Manager and other applicable trades to minimize surface mounted raceways.

3.04 WIRING DEVICES:

- A. Receptacles shall be mounted approximately 18" above floor or at other heights indicated on drawings.
- B. E.C. shall be responsible for protection of receptacles from painting, plastering, etc.
- C. Wall switches shall be mounted approximately 4'-0" above floor unless they interfere with wainscoting or trim.
- D. E.C. shall be responsible for masking switches for protection from painting, plastering, etc.
- E. E.C. shall confirm all door swings with Building Trades Contractor before installing switches.
- F. Wall plates shall be installed plumb and level with all edges in contact with attaching surface.
- G. E.C. shall confirm all ADA and barrier free requirements are meant and install according to their regulations.

3.05 SUPPORTS AND HANGERS:

- A. Provide and install necessary steel brackets, rods, clamps, etc., for support of all work under this contract. All supports shall be plated or painted and shall be secured to structural members after Architect's approval.

3.06 SLEEVES AND INSERTS:

- A. This Contractor shall be responsible for the proper location of all sleeves, chases, openings and inserts for the installation of his equipment.
- B. Holes through walls, floors or structural members shall be located only where permitted by the Architect/Engineer.

3.07 UNDERGROUND WORK:

- A. Prior to any underground excavating, trenching, pole base augering, etc. call MISS DIG at 811 no less than 72 hours in advance of any earthwork.

END OF SECTION

SECTION 16060
GROUNDING AND BONDING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Ground bars.
- E. Ground rod electrodes.

1.02 REFERENCE STANDARDS

- A. IEEE 81 - Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System; 2012.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; National Electrical Manufacturers Association; 2007.
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; International Electrical Testing Association; 2013 (ANSI/NETA ATS).
- E. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify exact locations of underground metal water service pipe entrances to building.
 - 2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
- B. Sequencing:
 - 1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.04 PERFORMANCE REQUIREMENTS

- A. Grounding System Resistance: 2.5 ohms or less.

1.05 SUBMITTALS

- A. Product Data: Provide for grounding electrodes and connections.
- B. Test Reports: Indicate overall resistance to ground and resistance of each electrode.
- C. Project Record Documents: Record actual locations of components and grounding electrodes.
- D. Certificate of Compliance: Indicate approval of installation by authority having jurisdiction.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

- A. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

- C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- D. Grounding System Resistance:
 - 1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Engineer. Precipitation within the previous 48 hours does not constitute normally dry conditions.
 - 2. Grounding Electrode System: Not greater than 25 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
- E. Grounding Electrode System:
 - 1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
 - a. Provide continuous grounding electrode conductors without splice or joint.
 - b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
 - 2. Metal Underground Water Pipe(s):
 - a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet (3.0 m) at an accessible location not more than 5 feet (1.5 m) from the point of entrance to the building.
 - b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
 - c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
 - 3. Metal Building or Structure Frame:
 - a. Provide connection to metal building or structure frame effectively grounded in accordance with NFPA 70 at nearest accessible location.
 - 4. Concrete-Encased Electrode:
 - a. Provide connection to concrete-encased electrode consisting of not less than 20 feet (6.0 m) of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.
 - 5. Ground Rod Electrode(s):
 - a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
 - b. Space electrodes not less than 10 feet (3.0 m) from each other and any other ground electrode.
 - c. Where location is not indicated, locate electrode(s) at least 5 feet (1.5 m) outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
 - 6. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
 - 7. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
 - a. Ground Bar Size: 1/4 by 2 by 12 inches (6 by 50 by 300 mm) unless otherwise indicated or required.
- F. Service-Supplied System Grounding:
 - 1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.

2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.
- G. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits:
1. Provide grounding electrode system for each separate building or structure.
 2. Provide equipment grounding conductor routed with supply conductors.
 3. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.
 4. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.
- H. Bonding and Equipment Grounding:
1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
 2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
 3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
 4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
 5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
 6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
- I. Communications Systems Grounding and Bonding:
1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.
 2. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
 - a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.
 - b. Raceway Size: 3/4 inch (21 mm) unless otherwise indicated or required.
 - c. Ground Bar Size: 1/4 by 2 by 12 inches (6 by 50 by 300 mm) unless otherwise indicated or required.
- J. Cable Tray Systems:
1. Comply with grounding and bonding requirements of NEMA VE 2.
 2. Metal Cable Tray Systems: Use suitable bonding jumpers or classified connectors to provide electrical continuity.
 3. Painted Cable Tray Systems: Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 4. Metal cable tray system may be used as sole equipment grounding conductor only where all conditional requirements of NFPA 70 are met.
- K. Pole-Mounted Luminaires: Also comply with Section 16560.

2.02 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
1. Provide products listed, classified, and labeled as suitable for the purpose intended.
 2. Provide products listed and labeled as complying with UL 467 where applicable.

- B. Conductors for Grounding and Bonding, in addition to requirements of Section 16050:
 - 1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
- C. Connectors for Grounding and Bonding:
 - 1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
 - 2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
 - 3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
- D. Ground Bars:
 - 1. Description: Copper rectangular ground bars with mounting brackets and insulators.
 - 2. Size: As indicated.
 - 3. Holes for Connections: As indicated or as required for connections to be made.
- E. Ground Rod Electrodes:
 - 1. Comply with NEMA GR 1.
 - 2. Material: Copper-bonded (copper-clad) steel.
 - 3. Size: 3/4 inch (19 mm) diameter by 10 feet (3.0 m) length, unless otherwise indicated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as shown on the drawings.
- C. Verify that conditions are satisfactory for installation prior to starting work.
- D. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install grounding and bonding system components in a neat and workmanlike manner in accordance with NECA 1.
- C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.
- D. Make grounding and bonding connections using specified connectors.
 - 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 - 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 - 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 - 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- E. Identify grounding and bonding system components in accordance with Section 16000.

- F. Install ground electrodes & building steel at locations indicated. Install bonding jumper to internal building metallic water piping system. (Please note that the new wells and associated underground water lines will be plastic PVC and can not be used as a Grounding Electrode). Install additional rod electrodes and/or building steel columns as required to achieve specified resistance to ground (5 ohms) or less..
- G. Provide grounding electrode conductor and connect to reinforcing steel in foundation footing where indicated. Bond steel together.
- H. Provide bonding to meet requirements described in Quality Assurance.
- I. Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

3.03 FIELD QUALITY CONTROL

- A. Perform inspection in accordance with Section 01400.
- B. Inspect and test in accordance with NETA ATS except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.13.
- D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

END OF SECTION

SECTION 16230
EMERGENCY POWER SYSTEM GENERATOR SET

PART - GENERAL

1.01 DESCRIPTION OF SYSTEM & SITE

- A. Provide an integrated paralleling, standby power system to supply electrical power at 120/208V, 60 Hz, and 3 Phase. The system will be based on generators rated approximately 250 kW each with the ability to scale up as necessary for future building additions. The generators shall consist of a liquid cooled spark-ignited engine, a synchronous AC alternator, a paralleling switch, and system controls with all necessary accessories for a complete operating system, including but not limited to the items as specified hereinafter.
- B. The generator shall be sized per manufacturer to cover the building loads listed in Groups within Specification Section 16230-2.01(A)(4) and as described in more detail in the Electrical Drawings.
- C. The site is an NEC ordinary location with no specific harsh environment requirements.
- D. The genset shall be applied at the listed ambient and elevation. Bidders to submit the generators rated power output at 122 degrees ambient (°F) and 1000 elevation (Ft).
- E. Bidders are to submit the genset's sound level in dBA at 23 ft (7 Meters) at 100% full load based on the configuration specified.
- F. The on-site gas pressure shall be 11-15 inches of water column.
- G. Reference Instructions to Bidders Section 11 for submitting alternates.

1.02 REQUIREMENTS OF REGULATORY AGENCIES

- A. An electric generating system, consisting of a prime mover, generator, governor, coupling and all controls, must have been tested, as a complete unit, on a representative engineering prototype model of the equipment to be sold.
- B. The generator set must conform to applicable NFPA requirements.
- C. The generator set must be available with the Underwriters Laboratories listing (UL2200) for a stationary engine generator assembly.
- D. The generator set must be pre-certified to meet EPA federal emission requirements for stationary standby. On-site emission testing & certification will not be acceptable for standby applications.
- E. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications

1.03 MANUFACTURER QUALIFICATIONS

- A. This system shall be supplied by an original equipment manufacturer (OEM) who has been regularly engaged in the production of engine-alternator sets, automatic transfer switches, and associated controls for a minimum of 25 years, thereby identifying one source of supply and responsibility. Approved suppliers are Generac Industrial Power, Cummins, Caterpillar, Kohler or an approved equal.
- B. The manufacturer shall have printed literature and brochures describing the standard series specified, not a one of a kind fabrication. Custom designed paralleling solutions using site specific PLC programs and site specific schematics are considered less desirable.
- C. Manufacturer's authorized service representative shall meet the following criteria:
 - 1. Certified, factory trained, industrial generator technicians
 - 2. Service support 24/7
 - 3. Service location within 200 miles
 - 4. Response time of 4 hours

5. Service & repair parts in-stock at performance level of 95%
6. Offer optional remote monitoring and diagnostic capabilities

1.04 SUBMITTALS

- A. Engine Generator specification sheet
- B. Controls specification sheet(s)
- C. Installation / Layout dimensional drawing
- D. Wiring schematic
- E. Sound data
- F. Emission certification
- G. Warranty statement
- H. Provide electronic copy of Engineering Submittal in PDF format for approval, prior to production release, showing all components, in addition to the engine and generator. Indicate electrical characteristics and connection requirements. Show plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, and electrical diagrams including schematic and interconnection diagrams.
- I. Submittals shall include line by line compliance with these specifications.

PART 2 - PRODUCTS

2.01 ENGINE

- A. Engine Rating and Performance
 1. The prime mover shall be a liquid cooled, spark-ignited, 4-cycle engine. It will have adequate horsepower to achieve rated kW output.
 2. The engine shall support a 100% load step with a maximum frequency dip of 12 Hz.
 3. The system shall be sized and sequenced to allow emergency system loads as defined by NEC 700 to be transferred onto the generator(s) within 10 seconds. Non-emergency system loads will be sequenced onto the generator(s) as generator capacity comes on-line.
 4. Performance - Vendors shall size equipment for the following loads and steps. All equipment vendors shall quote equipment that meets performance requirements:
 - a. Group 1 (Designated Emergency Life-Safety Loads – ATS#LS1):
 - 1) LED Emergency Lighting – 120V, single phase, ~10.0kW total
 - 2) Fire Alarm Panel – ~750W
 - b. Group 2 (ATS#3)
 - 1) HVAC Heat Pumps – Quantity of 2: 208V, three phase, 117.6 FLA total
 - 2) System Pumps – Quantity of 2: 208V, three phase, 30HP, 96.6 FLA total
 - 3) System Pumps – Quantity of 2: 208V, three phase, 15.4 FLA total
 - 4) Critical Cooling Unit – 208V, single phase, 2.4kVA
 - 5) Kitchen Equipment (various) – 208V, three phase, 48.3kVA (using 65% diversity allowed per 2011 NEC Section 250.65).
 - 6) Ventilation Make-Up Air Units – Quantity 2: 208V, three phase, 13.0 FLA total
 - 7) Kitchen Exhaust Fans – Quantity 3: 208V, three phase, 4.6kVA total
 - 8) HVAC Air Handlers – Quantity 2: 208V, three phase, 5.0 FLA total
 - 9) HVAC Condensing Units – Quantity 2: 208V, three phase, 38.4 FLA total
 - 10) Fountain Pump – 208V, three phase, 17.5 FLA total.
 - 11) Well and Irrigation Pumps – Quantity of 2: 208V, three phase, 20HP, 64.4 FLA total

- 12) Server Rack UPS – Quantity 2: 208V, single phase, 10kVA total
 - 12) Lighting – 120V, single phase ~12.6kW total
 - 13) General Receptacles – 120V, single phase, ~18.3kVA (using diversity factor)
 - 14) Miscellaneous Building Loads – various voltages, ~51.5kVA
- c. Group 3 (ATS#1)
- 1) HVAC Dedicated Outdoor Air Unit – 208V, three phase, 184.0 FLA
 - 2) HVAC Heat Pumps – Quantity of 3: 208V, three phase, 117.6 FLA total
 - 3) Lighting – 120V, single phase, ~2.7kW total
 - 4) General Receptacles – 120V, single phase, ~51.1kVA (using diversity factor)
 - 5) Miscellaneous Building Loads – various voltages, ~13.7kVA
- d. Group 4 (ATS#2)
- 1) Elevator – 208V, three phase, 20HP, 72.0 FLA
 - 2) HVAC Heat Pumps – Quantity of 4: 208V, three phase, 192.4 FLA total
 - 3) Lighting – 120V, single phase, ~10.2kW total
 - 4) General Receptacles – 120V, single phase, ~37.7kVA (using diversity factor)
 - 5) Miscellaneous Building Loads – various voltages, ~21.9kVA
 - 6) HVAC Make-up Air Unit, 208V, 1phase, 1.7kVA
5. With the above loads the paralleled generator package shall be loaded less than 80% of capacity, maximum frequency dip shall be less than 12 Hz and maximum starting voltage dip shall be 35% or less.
 6. Voltage regulation shall not exceed one percent for any constant load between no load and rated load. Random voltage variation with any steady load from no load to full load shall not exceed +/- 0.5 percent.
 7. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.25%.
 8. Cooling system shall not derate in the enclosure at temperatures below required 104°F.
- B. Engine Oil System
1. Full pressure lubrication shall be supplied by a positive displacement lube oil pump. The engine shall have a replaceable oil filter(s) with internal bypass and replaceable element(s).
 2. The engine shall operate on mineral based oil. Synthetic oils shall not be required.
- C. Engine Cooling System
1. The engine is to be cooled with a unit mounted radiator, fan, water pump, and closed coolant recovery system. The coolant system shall include a coolant fill box which will provide visual means to determine if the system has adequate coolant level. The radiator shall be designed for operation in 122 degrees F, (50 degrees C) ambient temperature.
 2. The engine shall have a) unit mounted, thermostatically controlled water jacket heater(s) to aid in quick starting. The wattage shall be as recommended by the manufacturer.
 3. Engine coolant and oil drain extensions, equipped with pipe plugs and shut-off valves, must be provided to the outside of the mounting base for cleaner and more convenient engine servicing.
 4. A radiator fan guard must be installed for personnel safety that meets UL and OSHA safety requirements.

D. Engine Starting System

1. Starting shall be by a solenoid shift, DC starting system.
2. The engine's cranking batteries shall be lead acid. The batteries shall be sized per the manufacturer's recommendations. The batteries supplied shall meet NFPA 110 cranking requirements of 90 seconds of total crank time. Battery specifications (type, amp-hour rating, cold cranking amps) to be provided in the submittal.
3. The genset shall have an engine driven, battery charging alternator with integrated voltage regulation.
4. The genset shall have an automatic dual rate, float equalize, 10 amp battery charger. The charger must be protected against a reverse polarity connection. The chargers charging current shall be monitored within the generator controller to support remote monitoring and diagnostics. The battery charger is to be factory installed on the generator set. Due to line voltage drop concerns, a battery charger mounted in the transfer switch will be unacceptable.

E. Engine Fuel System

1. The engine shall be configured to operate on pipe line grade natural gas.
2. The engine shall utilize a fuel system inclusive of carburetor, gas regulator, low gas pressure switch, and fuel shut-off solenoid. Generators larger than 80 kW are to include air-fuel-ratio control.
3. The engines internal fuel connections shall be terminated to the generator frame via an NPT fitting for easy installation.

F. Engine Controls

1. Engine speed shall be controlled with an integrated isochronous governor function with no change in alternator frequency from no load to full load. Steady state regulation is to be 0.25%.
2. To support EPA emission requirements, gensets larger than 80 kW will incorporate an active air-fuel-ratio controller. The air-fuel-ratio controller shall be integrated into the generator controller to ensure security of settings and to support monitoring and remote diagnostics. External air-fuel-ratio controllers are not acceptable.
3. Engine sensors used for monitoring and control are to be conditioned to a 4-20ma signal level to enhance noise immunity.
4. All engine sensor connections shall be sealed to prevent corrosion and improve reliability.

G. Engine Exhaust & Intake

1. The engine exhaust emissions shall meet the EPA emission requirements for standby power generation.
2. For generators larger than 80 kW, the engine will incorporate a 3-way catalytic convertor to meet EPA emission requirements.
3. The manufacturer shall supply its recommended stainless steel, flexible connector to couple the engine exhaust manifold to the exhaust system. A rain cap will terminate the exhaust pipe after the silencer. All components must be properly sized to assure operation without excessive back pressure when installed.
3. The manufacturer shall supply a critical grade exhaust silencer as standard. For applications with site specific sound requirements (reference section 1.1), the silencer shall be selected to achieve site sound levels.
4. For gensets in a weather or sound attenuated enclosure, all exhaust piping from the turbo-charger discharge to the silencer shall be thermally wrapped to minimize heat dissipation inside the enclosure.

5. The engine intake air is to be filtered with engine mounted, replaceable, dry element filters.

2.02 ALTERNATOR

- A. The alternator shall be the voltage and phase configuration as specified in section 1.0.1.
- B. The alternator shall be a 4 pole, revolving field, stationary armature, synchronous machine. The excitation system shall utilize a brushless exciter with a three phase full wave rectifier assembly protected against abnormal transient conditions by a surge protector. Photo-sensitive components will not be permitted in the rotating exciter.
- C. The alternator shall include a permanent magnet generator (PMG) for excitation support. The system shall supply a minimum short circuit support current of 300% of the rating (250% for 50Hz operation) for 10 seconds.
- D. The alternator shall support 692 skVA with a maximum voltage dip of 35%.
- E. Three phase alternators shall be 12 lead, broad range capable of supporting voltage reconnection. Single phase alternators shall be four lead and dedicated voltage designs (600v) shall be six lead. All leads must be extended into a NEMA 1 connection box for easy termination. A fully rated, isolated neutral connection must be included by the generator set manufacturer.
- F. The alternator shall use a single, sealed bearing design. The rotor shall be connected to the engine flywheel using flexible drive disks. The stator shall be direct connected to the engine to ensure permanent alignment.
- G. The alternator shall meet temperature rise standards of UL2200 (125 degrees C). The insulation system material shall be class "H" capable of withstanding 150 degrees C temperature rise.
- H. The alternator shall be protected against overloads and short circuit conditions by advanced control panel protective functions. The control panel is to provide a time current algorithm that protects the alternator against short circuits. To ensure precision protection and repeatable trip characteristics, these functions must be implemented electronically in the generator control panel -- thermal magnetic breaker implementation are not acceptable.
- I. An alternator strip heater shall be installed to prevent moisture condensation from forming on the alternator windings. A tropical coating shall also be applied to the alternator windings to provide additional protection against the entrance of moisture.

2.03 GENSET CONTROLS

- A. The generator control system shall be a fully integrated microprocessor based control system for standby emergency engine generators meeting all requirements of NFPA 110 level 1.
- B. The generator control system shall be a fully integrated control system enabling remote diagnostics and easy building management integration of all generator functions. The generator controller shall provide integrated and digital control over all generator functions including: engine protection, alternator protection, speed governing, voltage regulation, synchronizing, load-sharing (real and reactive) and all related generator operations.
- C. Communications shall be supported with building automation via the Modbus protocol without network cards. Optional internet and intranet connectivity shall be available.
- D. The control system shall provide an environmentally sealed design including encapsulated circuit boards and sealed automotive style plugs for all sensors and circuit board connections. The use of non-encapsulated boards, edge cards, and pc ribbon cable connections are considered unacceptable.
- E. Circuit boards shall utilize surface mount technology to provide vibration durability. Circuit boards that utilize large capacitors or heat sinks must utilize encapsulation methods to securely support these components.

- F. A predictive maintenance algorithm that alarms when maintenance is required. The controller shall have the capability to call out to the local servicing dealer when maintenance is required.
- G. Diagnostic capabilities should include time-stamped event and alarm logs, ability to capture operational parameters during events, simultaneous monitoring of all input or output parameters, callout capabilities, support for multi-channel digital strip chart functionality and .2 msec data logging capabilities.
- H. In addition to standard NFPA 110 alarms, the application loads should also be protected through instantaneous and steady state protective settings on system voltage, frequency, and power levels.
- I. The control system shall provide pre-wired customer use I/O: 4 relay outputs (user definable functions), 4 contact inputs, 2 analog inputs, communications support via RS232, RS485, or an optional modem. Additional I/O must be an available option.
- J. Customer I/O shall be software configurable providing full access to all alarm, event, data logging, and shutdown functionality. In addition, custom ladder logic functionality inside the generator controller shall be supported to provide application support flexibility. The ladder logic function shall have access to all the controller inputs and customer assignable outputs.
- K. The control panel shall include a digital display for all user pertinent unit parameters including: engine and alternator operating conditions; oil pressure and optional oil temperature; coolant temperature and level alarm; fuel level (where applicable); engine speed; DC battery voltage; run time hours; generator voltages, amps, frequency, kilowatts, and power factor; alarm status and current alarm(s) condition per NFPA 110 level 1.
- L. A 21 light remote annunciator, annunciator Flush Mount Kit and a Remote Emergency Stop Switch (Break Glass type) shall be included.

2.04 PARALLELING SYSTEM CONTROLLER

- A. The system controller shall be an integrated microprocessor based solution providing full digital integration with the generator controllers. The system controller shall utilize standard hardware and firmware manufactured by the generator supplier. The use of PLC based solutions will be considered less desirable due to reliability and support concerns posed by custom hardware/custom software solutions. A preference will be shown for designs that use the same control board hardware for both the generator(s) and system controller.
- B. To ensure reliability and serviceability, the system controller shall be required to meet the same requirements as listed for the generator controller in sections 2.03(C) to 2.03(G) and 2.03(J).
- C. The control panel will provide a touch screen display to provide intuitive access to all user pertinent system status information.
- D. The power for the system controller shall utilize redundant DC sources - an internal DC source inclusive of charging system and an external DC source from one of the generator's cranking batteries.
- E. The system controller shall interface with the generators using digital communications. Any of the generator(s) status, operation conditions, or configuration parameters shall be accessible with a single point communication via the system controller.
- F. The system controller shall provide sequence of facility load through 3 priority loading (permissive) load steps and 3 load shedding steps. These output parameters function based on the number of generators on the generator bus. The priority loading function provides sequential permissive contact closures enabling load to be transferred onto the generator in response to generators coming on-line. The load shedding function provides contact closures that disconnects load from the generator bus in response to a reduction in available generator capacity.
- G. In addition to the communication requirements identified in 2.03(C), the system controller shall provide modem communications as standard.

- H. The system controller and digital communications shall enhance system operation but neither shall be required to synchronize or operate the generators in parallel. Systems that require external control hardware or digital communications to synchronize and operate the generators in parallel are not acceptable.
- I. The design of the system shall allow continued generator paralleled operation with failures to the system controller and/or communication. Control systems that have any systemic single point failure modes are not acceptable. This is inclusive of systems that rely on reactive cross current and isochronous load sharing control loops. Control systems that rely on redundant communications will be evaluated for potential common mode failures that can impact both of communication channels.

2.05 TYPICAL/NORMAL OPERATING SEQUENCE

- A. Upon the failure of utility power, the automatic transfer switch(es) (ATS) provides a two-wire start signal to the system controller. The system controller sends a start command to the generators via RS485 communication. The first generator that reaches rated voltage and frequency requests permission to close into the "dead" generator bus. This is to provide dead bus arbitration. After this process, the generator closes its paralleling switch connecting to the generator bus.
- B. If the system has an emergency system transfer switch, it will typically transfer to the first generator on-line. If the emergency system load is larger than a single unit, two generators may be configured to come on-line prior to transferring the emergency system load.
- C. The system controller compares the on-line generator capacity to additional load segmentation. When adequate generator capacity becomes available, the system controller enables the priority one loads to be switched to the generator bus. This is typical accomplished by providing a permissive contact to the ATS. The system controller shall support 3 load steps.
- D. Additional generators upon sensing generator bus voltage, synchronize and parallel to the generator bus.
- E. The system controller shall provide load-shed capability via programmed outputs based on a comparison of the number of generators on-line and connected load requirements. Three load-shed outputs shall be provided for this purpose. Load shedding may not need to occur in systems with planned for additional generator capacity or in systems that are lightly load due to typical load factors. The system controller shall be easily reconfigured to match expected load conditions. Load shedding is possible through an ATS, shunt trip breakers, or control circuits.
- F. Once utility power has returned, the two-wire start signal will be removed. The generator paralleling contactors will open, generators will run in a cool down mode, and then generators shut down.
- G. Transfer switch(es) supplied shall be capable of being inhibited from transferring with a contact from the system controller. The transfer switches supplied shall also be able to shed load via trip-to-neutral feature -- the load is shed and does not re-close to a utility that may have a fault present. For applications in which load shedding with the transfer switch is not feasible, load shedding requirements will be evaluated and accommodated as necessary.

2.04 ENGINE / ALTERNATOR PACKAGING

- A. The engine/alternator shall be mounted with internal vibration isolation onto a welded steel base. These units shall not need external vibration isolation for normal pad mounted applications.

- B. A mainline, thermal magnetic circuit breaker carrying the UL mark shall be factory installed. The breaker shall be rated between 100 to 125% of the rated ampacity of the genset. The line side connections are to feed from the alternator, and the load side of the breaker shall feed a paralleling switch. The breaker is to have aux contact and shunt trip. The breaker will function as a redundant tripping device in the system. If the paralleling switch fails to open, the generator breaker will be shunt tripped.
- C. Each generator shall include a cycle rated paralleling switch using proven contactor technology. The mechanism shall have a minimum cycle life of 20,000 operations. The generator paralleling switch shall be mounted in the generator connection box. Solutions utilizing motor operated or stored energy breakers for generator paralleling shall provide documentation of 20,000 operation cycle rating capability.
- D. The generator shall include a unit mounted 120 volt convenience outlet.

2.06 ENCLOSURE

- A. The genset shall be packaged with a Level 1 Sound Attenuating Enclosure that must be at or less than an average of 78.0 dBA at 23 feet (7 Meters) at 100% load.
- B. The enclosure shall be completely lined with sound deadening material. This material must be of a self-extinguishing design.
- C. The enclosure shall be made of steel with a minimum thickness of 14 gauge. The enclosure is to have hinged, removable doors to allow access to the engine, alternator and control panel. The hinges shall allow for door fit adjustment. Hinges and all exposed fasteners will be stainless steel or JS5000. The use of pop-rivets weakens the paint system and not allowed on external painted surfaces. Each door will have lockable hardware with identical keys.
- D. The enclosure shall be coated with electrostatic applied powder paint, baked and finished to manufacturer's specifications. The color will be manufacturer's standard.
- E. The enclosure shall utilize an upward discharging radiator hood. Due to concerns relative to radiator damage, circulating exhaust, and prevailing winds, equipment without a radiator discharge hood will not be acceptable.
- F. The genset silencer shall be mounted on the discharge hood of the enclosure. Due to architectural concerns, silencers mounted on the top of the generator enclosure are not acceptable. Gensets with silencers mounted inside the main generator compartment are acceptable only if the silencer is thermally wrapped to minimize heat stress on the surrounding components.

2.07 LOOSE ITEMS

- A. Supplier to itemize loose parts that require site mounting and installation. Preference will be shown for gensets that factory mount items like mufflers, battery chargers, etc.
- B. Flexible fuel hose for use in gas piping installation.
- C. Spare Parts:
 - 1. Fuses: One spare set
 - 2. Filters One spare set (air, fuel, oil)

PART 3 - OPERATION

3.01 SEQUENCE OF OPERATION

- A. Generator set shall start on receipt of a start signal from remote equipment. The start signal shall be via hardwired connection to the generator set control and a redundant signal over the required network connection.
- B. The generator set shall complete a time delay start period as programmed into the control.

- C. The generator set control shall initiate the starting sequence for the generator set. The starting sequence shall include the following functions:
 - 1. The control system shall verify that the engine is rotating when the starter is signaled to operate. If the engine does not rotate after two attempts, the control system shall shut down and lock out the generator set, and indicate "fail to crank" shutdown.
 - 2. The engine shall fire and accelerate as quickly as practical to start disconnect speed. If the engine does not start, it shall complete a cycle cranking process as described elsewhere in this specification. If the engine has not started by the completion of the cycle cranking sequence, it shall be shut down and locked out, and the control system shall indicate "fail to start".
 - 3. The engine shall accelerate to rated speed and the alternator to rated voltage. Excitation shall be disabled until the engine has exceeded programmed idle speed, and regulated to prevent over voltage conditions and oscillation as the engine accelerates and the alternator builds to rated voltage.
- D. On reaching rated speed and voltage, the generator set shall operate as dictated by the control system in isochronous, synchronize, load share, load demand, or load govern state.
- E. When all start signals have been removed from the generator set, it shall complete a time delay stop sequence. The duration of the time delay stop period shall be adjustable by the operator.
- F. On completion of the time delay stop period, the generator set control shall switch off the excitation system and shall shut down.
 - 1. Any start signal received after the time stop sequence has begun shall immediately terminate the stopping sequence and return the generator set to isochronous operation.

PART 4 – OTHER REQUIREMENTS

4.01 FACTORY TESTING

- A. Before shipment of the equipment, the engine-generator set shall be tested under rated load for performance and proper functioning of control and interfacing circuits. Tests shall include:
 - 1. A certified factory test report for a minimum of 1 hour at rated 0.8 PF shall be provided
Verify voltage & frequency stability.
 - 2. Verify transient voltage & frequency dip response.
 - 3. Load test the generator for 30 minutes.
 - 4. Verify paralleling and load sharing capabilities

4.02 OWNER'S MANUALS

- A. Three (3) sets of owner's manuals specific to the product supplied must accompany delivery of the equipment. General operating instruction, preventive maintenance, wiring diagrams, schematics and parts exploded views specific to this model must be included.

4.03 INSTALLATION

- A. Contractor shall install the complete electrical generating system including all external fuel connections in accordance with requirements of NEC, NFPA, and the manufacturer's recommendations as reviewed by the Engineer.
- B. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.
- C. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.

4.04 SERVICE

- A. Supplier of the genset and associated items shall have permanent service facilities in this trade area. These facilities shall comprise a permanent force of EGSA certified and factory trained service personnel on 24 hour call, experienced in servicing this type of equipment, providing

warranty and routine maintenance service to afford the owner maximum protection. Delegation of this service responsibility for any of the equipment listed herein will not be considered fulfillment of these specifications. Service contracts shall also be available.

4.05 WARRANTY

- A. The standby electric generating system components, complete genset and instrumentation panel shall be warranted by the manufacturer against defective materials and factory workmanship for a period of five (5) years. Such defective parts shall be repaired or replaced at the manufacturer's option, free of charge for parts, labor and travel.
- B. The warranty period shall commence when the emergency power system is first placed into service. Multiple warranties for individual components (engine, alternator, controls, etc.) will not be acceptable. Satisfactory warranty documents must be provided. Also, in the judgment of the specifying authority, the manufacturer supplying the warranty for the complete system must have the necessary financial strength and technical expertise with all components supplied to provide adequate warranty support.

4.06 STARTUP AND COMMISSIONING

- A. The supplier of the electric generating plant and associated items covered herein shall provide factory trained technicians to examine the completed installation and to perform an initial startup inspection to include:
 - 1. Ensuring the engine starts (both hot and cold) within the specified time.
 - 2. Verification of engine parameters within specification.
 - 3. Verify no load frequency and voltage, adjusting if required.
 - 4. Test all automatic shutdowns of the engine-generator.
 - 5. Perform a load test of the electric plant, ensuring full load frequency and voltage are within specification by using building load.
 - 6. Installation acceptance tests to be conducted on-site shall include a "cold start" test, a two hour full load test, and a one step 100% rated full load pick up test in accordance NFPA110. Provide a resistive load bank test and make connections for testing. Record engine coolant temperature, oil pressure, ambient temperature, phase to phase voltage, phase to phase current and frequency at fifteen minute intervals.

4.07 TRAINING

- A. Training is to be supplied by the start-up technician during commissioning. The training should cover basic generator operation and common generator issues that can be managed by the end-user. Date shall be coordinated with the Owner (or Owner's representative).

END OF SECTION

SECTION 16231
EMERGENCY POWER SYSTEMS AUTOMATIC TRANSFER SWITCHES

PART 1 GENERAL

1.01 SCOPE

- A. The automatic transfer switches shall be furnished by the manufacturer of the engine-generator set so as to maintain system compatibility and local service responsibility for the complete emergency power system. It shall be listed by Underwriter's Laboratory, Standard 1008 with fuse or circuit breaker protection. Representative production samples of the transfer switch supplied shall have demonstrated through tests the ability to withstand at least 10,000 mechanical operation cycles. One operation cycle is the electrically operated transfer from normal to emergency and back to normal. Wiring must comply with NEC table 312.6. The manufacturer shall furnish schematic and wiring diagrams for the particular automatic transfer switch and a typical wiring diagram for the entire system.

1.02 CODES AND STANDARDS

- A. The automatic transfer switches and accessories shall conform to the requirements of:
1. UL 1008 - Standard for Automatic Transfer Switches
 2. CSA C22.2 No.178 – 1978
 3. NFPA 70 - National Electrical Code
 4. NFPA 99 – Health Care Facilities
 5. NFPA 110 - Emergency and Standby Power Systems
 6. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
 7. NFPA20 – Fire Pumps. Transfer switches serving fire pumps shall be specifically listed and labeled for that application.
 8. NEMA Standard ICS10-2005 (formerly ICS2-447) - AC Automatic Transfer Switches
 9. NEC Articles 700, 701, 702
 10. International Standards Organization ISO 9001: 2008

PART 2 PRODUCTS

2.01 RATINGS & PERFORMANCES

- A. The automatic transfer switches shall be 3 poles, 208 volts, amps as shown on the Electrical Riser Diagram.
- B. It shall be rated for continuous operation in ambient temperatures of -20 degrees Fahrenheit (-30 degrees Celsius) to +140 degrees Fahrenheit (+60 degrees Celsius).
- C. Main power switch contacts shall be rated for 600 V AC minimum.
- D. The transfer switch supplied shall have a minimum withstand and closing rating when fuse protected of 200,000 amperes. Where the line side over current protection is provided by circuit breakers, the short circuit withstand and closing ratings shall be 14,000 amperes RMS. These RMS symmetrical fault current ratings shall be the rating listed in the UL listing or component recognition procedures for the transfer switch.
- E. All withstand tests shall be performed with the over current protective devices located external to the transfer switch. The transfer switch unit shall be electrically operated and mechanically held.
- F. The electrical operator shall be a single-solenoid mechanism, momentarily energized. Main operators which include over current disconnect devices will not be accepted.
- G. The switch shall be mechanically interlocked to ensure only one of two possible positions, normal or emergency.

2.02 CONTROLS

- A. All control equipment shall be mounted on the inside of the cabinet door in a metal lockable enclosure with transparent safety shield to protect all solid state circuit boards. This will allow for ease of service access when main cabinet lockable door is open, but to prevent access by unauthorized personnel. Control boards shall have installed cover plates to avoid shock hazard while making control adjustments. The solid state voltage sensors and time delay modules shall be plug-in circuit boards with silver or gold contacts for ease of service.
- B. A solid state under voltage sensor shall monitor all phases of the normal source and provide adjustable ranges for field adjustments for specific application needs. Pick-up and drop-out settings shall be adjustable from a minimum of 70% to a maximum of 95% of nominal voltage. A utility sensing interface shall be used, stepping down system voltage of 208/120 VAC 3 phase to 24VAC, helping to protect the printed circuit board from voltage spikes and increasing personnel safety when troubleshooting.
- C. A solid state under voltage sensor shall monitor all phases of the normal source and provide adjustable ranges for field adjustments for specific application needs. Pick-up and drop-out settings shall be adjustable from a minimum of 70% to a maximum of 95% of nominal voltage. A utility sensing interface shall be used, stepping down system voltage of 208/120 VAC 3 phase to 24VAC, helping to protect the printed circuit board from voltage spikes and increasing personnel safety when troubleshooting.
- D. Signal the engine-generator set to start in the event of a power interruption. A set of contacts shall close to start the engine and open for engine shutdown. A solid state time delay start, adjustable, .1 to 10 seconds, shall delay this signal to avoid nuisance start-ups on momentary voltage dips or power outages.
- E. Transfer the load to the engine-generator set after it reached proper voltage, adjustable from 70-90% of system voltage, and frequency, adjustable from 80-90% of system frequency. A solid state time delay, adjustable from 5 seconds to 3 minutes, shall delay this transfer to allow the engine-generator to warm-up before application of load. There shall be a switch to bypass this warm-up timer when immediate transfer is required.
- F. Retransfer the load to the line after normal power restoration. A return to utility timer, adjustable from 1-30 minutes, shall delay this transfer to avoid short term normal power restoration
- G. The operating power for transfer and retransfer shall be obtained from the source to which the load is being transferred. Controls shall provide an automatic retransfer of the load from emergency to normal if the emergency source fails with the normal source available.
- H. Signal the engine-generator to stop after the load retransfers to normal. A solid state engine cool down timer, adjustable from 1-30 minutes, shall permit the engine to run unloaded to cool down before shutdown. Should the utility power fail during this time, the switch will immediately transfer back to the generator.
- I. Provide an engine minimum run timer, adjustable from 5-30 minutes, to ensure an adequate engine run period.
- J. 2.4.10. The transfer switch shall have a time delay neutral feature to provide a time delay, adjustable from .1-10 seconds, during the transfer in either direction, during which time the load is isolated from both power sources. This allows residual voltage components of motors or other inductive loads (such as transformers) to decay before completing the switching cycle. A switch will be provided to bypass all transition features when immediate transfer is required.
- K. The transfer switch shall have an in phase monitor which allows the switch to transfer between live sources if their voltage waveforms become synchronous within 20 electrical degrees within 10 seconds of transfer initiation signal. A switch must be provided to bypass this feature if not required.

- L. If the in phase monitor will not allow such a transfer, the control must default to time delay neutral operation. Switches with in phase monitors which do not default to time delay neutral operation are not acceptable.
- M. Front mounted controls shall include a selector switch to provide for a NORMAL TEST mode with full use of time delays, FAST TEST mode which bypasses all time delays to allow for testing the entire system in less than one minute, or AUTOMATIC mode to set the system for normal operation.
- N. provide bright lamps to indicate the transfer switch position in either UTILITY (white) or EMERGENCY (red). A third lamp is needed to indicate STANDBY OPERATING (amber). These lights must be energized from utility or the engine-generator set.
- O. Provide manual operating handle to allow for manual transfer. This handle must be mounted inside the lockable enclosure so accessible only by authorized personnel.
- P. Provide a maintenance disconnect switch to prevent load transfer and automatic engine start while performing maintenance. This switch will also be used for manual transfer switch operation.
- Q. Provide LED status lights to give a visual readout of the operating sequence. This shall include utility on, engine warm-up, standby ready, transfer to standby, in phase monitor, time delay neutral, return to utility, engine cool down and engine minimum run. A "signal before transfer" lamp shall be supplied to operate from optional circuitry.

2.03 ENCLOSURE

- A. Enclosures shall be the NEMA type specified. The cabinet shall provide code-required wire bend space at point of entry as shown on the drawings. Manual operating handles and all control switches (other than key-operated switches) shall be accessible to authorized personnel only by opening the key-locking cabinet door. Transfer switches with manual operating handles and/or non key-operated control switches located on outside of cabinet do not meet this specification and are not acceptable.

2.04 MISCELLANEOUS TRANSFER SWITCH EQUIPMENT

- A. The transfer switch mechanism and controls are to be mounted in a NEMA 1 enclosure.
- B. Provide Trip to Neutral transfer switches for load shedding purposes.
- C. A second set of DPDT (form C), 10 ampere, 250 volt auxiliary contacts, operated by the transfer switch mechanism shall be installed.
- D. Provide Elevator Pre-signal contacts with adjustable time delay prior to transferring.

PART 3. OPERATION

3.01 OPEN TRANSITION SEQUENCE OF OPERATION

- A. Transfer switch normally connects an energized utility power source (source 1) to loads and a generator set (source 2) to the loads when normal source fails. The normal position of the transfer switch is source 1 (connected to the utility), and no start signal is supplied to the genset.
- B. Generator Set Exercise (Test) With Load Mode. The control system shall be configurable to test the generator set under load. In this mode, the transfer switch shall control the generator set in the following sequence:
 - 1. Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.
 - 2. The transfer switch shall issue a compatible start command to the generator set, and cause the generator set to start and run at idle until it has reached normal operating temperature.

3. When the generator set has reached normal operating temperature or after an adjustable time period (whichever is shorter), the control system shall accelerate the generator set to rated voltage and frequency.
 4. When the control systems senses the generator set at rated voltage and frequency, it shall operate to connect the loads to the generator set by opening the normal source contacts, and closing the alternate source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.
 5. The generator set shall operate connected to the load for the duration of the exercise period. If the generator set fails during this period, the transfer switch shall automatically reconnect the generator set to the normal service.
 6. On completion of the exercise period, the transfer switch shall operate to connect the loads to the normal source by opening the alternate source contacts, and closing the normal source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.
 7. The transfer switch shall operate the generator set unloaded for a cooldown period, and then remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.
- C. Generator Set Exercise (Test) Without Load Mode. The control system shall be configurable to test the generator set without transfer switch load connected. In this mode, the transfer switch shall control the generator set in the following sequence:
1. Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.
 2. The transfer switch shall issue a compatible start command to the generator set, and cause the generator set to start and run at idle until it has reached normal operating temperature.
 3. When the generator set has reached normal operating temperature or after an adjustable time period (whichever is shorter), the control system shall accelerate the generator set to rated voltage and frequency.
 4. When the control systems senses the generator set at rated voltage and frequency, it shall operate the generator set unloaded for the duration of the exercise period.
 5. At the completion of the exercise period, the transfer switch shall remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.

PART 4 ADDITIONAL REQUIREMENTS

4.02 TESTS AND CERTIFICATION

- A. The complete 3ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.
- B. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.
- C. The ATS manufacturer shall be certified to ISO 9001: 2008 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001: 2008.

4.03 SERVICE REPRESENTATION

- A. The ATS manufacturer shall maintain a national service organization of company- employed personnel located throughout the contiguous United States. The service center's personnel must be factory trained and must be on call 24 hours a day, 365 days a year.
- B. The manufacturer shall maintain records of switch shipments, by serial number, for a minimum of 20 years.
- C. For ease of maintenance, the transfer switch nameplate shall include drawing numbers and serviceable part numbers.

END OF SECTION

SECTION 16289
SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Surge Protective Devices (SPD) formerly known as Transient Voltage Surge Suppression (TVSS) for Service Entrance and Distribution Panel applications.

1.02 REFERENCES

- A. ANSI/IEEE C.62.41 and C62.45
- B. UL 1449 – 3rd Edition (Sept. 2009)
- C. UL 1283
- D. NEC – NFPA 70
- E. NFPA
- F. OSHA
- G. IEEE Std. 1100

1.03 SUBMITTALS

- A. Shop Drawings: Provide Shop Drawings with wiring diagrams, installation information, testing and maintenance procedures, and operational information for the transient protection system. Shop Drawings shall be submitted to Engineer for approval before starting actual fabrication.
- B. Submittals for Approval: Provide the following test data submittals:
 - 1. Manufacturer will provide UL-1449, 3rd Edition data card showing the Voltage Protection Rating (VPR) and "Engineering Considerations" for the specific catalog number submitted.
 - 2. Per the requirements of NEC Article 285.6, the devices shall be marked with the short circuit current rating. This rating shall meet or exceed the available fault current. Test data shall be provided to demonstrate the short circuit current rating has been tested on a complete device.
 - 3. Submit test report data clearly demonstrating the maximum surge current rating has been tested on a COMPLETE SPD unit including all necessary fusing/overcurrent protection, thermal disconnects, integral disconnects and monitoring systems. Manufacturers who cannot provide this data will not be approved.
 - 4. Submit data demonstrating that the SPD unit is capable of surviving the specified minimum repetitive surge current rating. The rating is based on surviving a specified number of ANSI/IEEE C62.41, Category C3 (10kA) impulses without failure or degradation in performance characteristics of more than 10%.
 - 5. Written detailed response to each paragraph of the specification indicating that the proposed product meets or exceeds this specification. If specific paragraphs are not met, provide written explanation as to why not.

PART 2 - SERVICE ENTRANCE SPD

2.01 ENVIRONMENTAL

- A. General Requirements:
 - 1. No audible noise shall be generated.
 - 2. No appreciable magnetic fields shall be generated. System shall be capable of use directly in computer rooms in any location without danger to disc units, disk packs, or tapes.
 - 3. Operating Conditions:
 - a. 30 – 130 Degrees F
 - b. 15 – 85 Percent Humidity Non-Condensing
 - 4. Enclosure: The unit shall have a heavy duty NEMA 12 dust-tight, drip-tight enclosure unless specified otherwise.

2.02 GENERAL REQUIREMENTS

- A. The manufacturer shall provide a surge protective device that is classified by UL-1449, 3rd Edition as a Type 1 device. All fusing and protective elements shall be included within the SPD enclosure. Devices that require external fusing or protective breakers are not acceptable.
- B. SPD shall be rated for a 480Y/277 volt, 60 Hertz, 3-phase, 4-wire system and shall be connected in parallel with the main switchboard.
- C. Nominal Current Discharge Level (In): The peak value of surge current through the SPD, selected by the manufacturer, having a current wave-shape of 8x20ms where the SPD remains functional after 15 surges shall be 20kA per mode.
- D. Quality: The manufacturer shall be ISO 9001 certified, demonstrating world-class quality systems for the design and manufacture of the SPD units.
- E. Unit shall be UL 1449, 3rd Edition Listed. A SPD that is a UL "Recognized" component will not be accepted.
- F. Unit shall offer a true, coordinated multi-stage system of suppression. It shall integrate the fast response time of a primary Silicone Avalanche Diode (SAD) stage with the high-energy capability of the standard Liebert Interceptor MOV (Metal Oxide Varistor) secondary stage. A patented Surge Current Transition Circuit is necessary to continually monitor the operating level of the SAD-switching to the secondary network of MOVs to identify issues long before component failure becomes a concern.
- G. A solid state comparator network shall actively switch the SAD components out of the transient control circuit when exposed to line voltages in excess of their Maximum Continuous operating Voltage (MCOV). While SAD components are removed from the system, an appropriately sized transient control network is available for continued protection. During this disconnect phase, the nominal levels shall be continually monitored until the system voltage is stable, at which point the SAD circuit is brought back on line.
- H. Second, a regulated amount of high energy surge current shall be transitioned to the secondary MOV suppression modules. This shall be accomplished through an impedance matching network utilizing a series of controlled copper geometries in conjunction with custom engineered high-voltage/high-energy component distribution. This shall ultimately limit the amount of high-energy surge current through the SAD module to an acceptable level and divert the remaining surge current through the MOV module.
- I. Each surge suppression element (MOV & SAD) shall be individually fused so that a failure of one element and/or fuse shall not affect other surge suppression elements. SPD shall have a short-circuit rating of 200kAIC. Devices that accomplish this rating by suggesting or providing additional fusing to the SPD system will not be accepted.
- J. Unit shall include solid-state, long-life externally mounted LED visual status indicators that indicate the on-line status and operational integrity of each phase of the unit.
- K. Unit shall have a Form C summary alarm output contact rated for at least 1 amp at 120VAC for remote annunciation of SPD status.

2.03 MANUFACTURERS AND SPECIFIC PRODUCT REQUIREMENTS

- A. Unit shall provide maximum UL 1449, 3rd Edition Voltage Protection Rating (VPR) for 208Y/120 Volt systems as follows:
 - 1. L-N = 700V
 - 2. L-G = 700V
 - 3. N-G = 700V
 - 4. L-L = 1000V
- B. The SPD will be modular in design. Separate and replaceable suppression modules will protect each mode (L-N, L-G, and N-G).

- C. The service entrance SPD will be capable of surviving 15,000 ANSI/IEEE, Category C3 (10kA) impulses without failure or degradation of original performance characteristics of more than 10%
- D. Unit shall have a maximum surge current rating of 125,000 amperes L-N, 125,000 amperes L-G, and 125,000 amperes N-G, based on ANSI/IEEE C62.41 standard 8 by 20 microsecond current waveform.
- E. Unit shall include a built-in, push-to-test feature that tests the integrity of all modules, SADs, MOVs, and fuses in the system. Manufacturers that require an external test device to perform this feature will include the test set in this quotation.
- F. Unit shall be provided with an integral, non-fused disconnect switch which causes no interruption to the protected load for testing and maintenance. Disconnect system shall not require removal or replacement for warranty or other repairs.
- G. Unit shall have an audible alarm with an alarm on/off switch to silence the alarm and a push-to-test switch to test the alarm function.
- H. A resettable counter shall be provided to totalize transient voltage surges in both the normal and common mode. The readout shall be at least a six-digit LCD located on the unit front cover and provided with a 10-year battery back-up to maintain counts in the event of power loss.
- I. Warranty: Manufacturer shall provide a product warranty for a period of not less than 10 years from date of installation. Warranty shall cover unlimited replacement of system protection modules during warranty period. The first 5 years of this warranty will include any field labor required to perform repair or replacement work.

PART 3 - SUB PANEL SPD

3.01 ENVIRONMENTAL

- A. General Requirements:
 - 1. No audible noise shall be generated.
 - 2. No appreciable magnetic fields shall be generated. System shall be capable of use directly in computer rooms in any location without danger to disc units, disk packs, or tapes.
 - 3. Operating Conditions:
 - a. 30 – 130 Degrees F
 - b. 15 – 85 Percent Humidity Non-Condensing
 - 4. Enclosure: The unit shall have a heavy duty NEMA 12 dust-tight, drip-tight enclosure unless specified otherwise.

3.02 GENERAL REQUIREMENTS

- A. The manufacturer shall provide a surge protective device that is classified by UL-1449, 3rd Edition as a Type 1 device. All fusing and protective elements shall be included within the SPD enclosure. Devices that require external fusing or protective breakers are not acceptable.
- B. SPD shall be rated for a 480Y/277 volt, 60 Hertz, 3-phase, 4-wire system and shall be connected in parallel with the main switchboard.
- C. Nominal Current Discharge Level (In): The peak value of surge current through the SPD, selected by the manufacturer, having a current wave-shape of 8x20ms where the SPD remains functional after 15 surges shall be 20kA per mode.
- D. Quality: The manufacturer shall be ISO 9001 certified, demonstrating world-class quality systems for the design and manufacture of the SPD units.
- E. Unit shall be UL 1449, 3rd Edition Listed. A SPD that is a UL "Recognized" component will not be accepted.
- F. Each surge suppression element (MOV) shall be individually fused so that a failure of one element and/or fuse shall not affect other surge suppression elements. SPD shall have a short-

circuit rating of 200kAIC. Devices that accomplish this rating by suggesting or providing additional fusing to the SPD system will not be accepted.

- G. Unit shall include solid-state, long-life externally mounted LED visual status indicators that indicate the on-line status and operational integrity of each phase of the unit.
- H. Unit shall have a Form C summary alarm output contact rated for at least 1 amp at 120VAC for remote annunciation of SPD status.

3.03 MANUFACTURERS AND SPECIFIC PRODUCT REQUIREMENTS

- A. Acceptable Manufacturers: Subject to compliance with requirements of the Contract Documents, acceptable manufacturers are as follows, no substitutions:
 - 1. Liebert: Interceptor II, 560 Series
- B. Unit shall provide maximum UL 1449, 3rd Edition Voltage Protection Rating (VPR) for 208Y/120 Volt systems as follows:
 - 1. L-N = 700V
 - 2. L-G = 700V
 - 3. N-G = 700V
 - 4. L-L = 1000V
- C. Unit shall provide maximum UL 1449, 3rd Edition Voltage Protection Rating (VPR) for 480Y/277 Volt systems as follows:
 - 1. L-N = 1000V
 - 2. L-G = 1200V
 - 3. N-G = 1000V
 - 4. L-L = 1800V
- D. The SPD will be modular in design. Separate and replaceable suppression modules will protect each mode (L-N, L-G, and N-G).
- E. The service entrance SPD will be capable of surviving 15,000 ANSI/IEEE, Category C3 (10kA) impulses without failure or degradation of original performance characteristics of more than 10%
- F. Unit shall have a maximum surge current rating of 125,000 amperes L-N, 125,000 amperes L-G, and 125,000 amperes N-G, based on ANSI/IEEE C62.41 standard 8 by 20 microsecond current waveform.
- G. Unit shall include a built-in, push-to-test feature that tests the integrity of all modules, MOVs, and fuses in the system. Manufacturers that require an external test device to perform this feature will include the test set in this quotation.
- H. Unit shall be provided with an integral, non-fused disconnect switch which causes no interruption to the protected load for testing and maintenance. Disconnect system shall not require removal or replacement for warranty or other repairs.
- I. Unit shall have an audible alarm with an alarm on/off switch to silence the alarm and a push-to-test switch to test the alarm function.
- J. A resettable counter shall be provided to totalize transient voltage surges in both the normal and common mode. The readout shall be at least a six-digit LCD located on the unit front cover and provided with a 10-year battery back-up to maintain counts in the event of power loss.
- K. Warranty: Manufacturer shall provide a product warranty for a period of not less than 10 years from date of installation. Warranty shall cover unlimited replacement of system protection modules during warranty period. The first 5 years of this warranty will include any field labor required to perform repair or replacement work.

PART 4 EXECUTION

4.01 INSTALLATION

- A. General Requirements:
 - 1. Contractor shall install suppression system immediately next to or on top of service equipment where so approved by the Engineer:
 - 2. Conductors between suppressor and point of attachment to service equipment shall be sized in accordance with manufacturer's Shop Drawings and conductor lengths shall be as short as possible, preferably not exceeding 24".
- B. Grounding: Suppressor ground shall be bonded to the equipment grounding conductor and service entrance ground.

END OF SECTION

SECTION 16510
INTERIOR LUMINAIRES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Interior luminaires.
- B. Exit signs.
- C. Fluorescent emergency power supply units.
- D. Lamps.
- E. Luminaire accessories.

1.02 REFERENCE STANDARDS

- A. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; Illuminating Engineering Society; 2008.
- B. IES LM-80 - Approved Method: Measuring Lumen Maintenance of LED Light Sources; Illuminating Engineering Society; 2008.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- D. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; National Electrical Contractors Association; 2006.
- E. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; National Electrical Contractors Association; 2006.
- F. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; National Electrical Manufacturers Association; 2012.
- G. NFPA 70 - National Electrical Code; National Fire Protection Association; 2002.
- H. NFPA 101 - Life Safety Code; National Fire Protection Association; 2012.
- I. UL 844 - Luminaires for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.
- J. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.
- K. UL 935 - Fluorescent-Lamp Ballasts; Current Edition, Including All Revisions.
- L. UL 1598 - Luminaires; Current Edition, Including All Revisions.
- M. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A. Provide photometric calculations where luminaires are proposed for substitution upon request.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
 - 1. LED Luminaires:
 - a. Include estimated useful life, calculated based on IES LM-80 test data.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.04 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70 and NFPA 101.

1.05 DELIVERY, STORAGE, AND PROTECTION

- A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting) and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

PART 2 PRODUCTS

2.01 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the drawings. For voluntary alternates, see section 16010.

2.02 LUMINAIRES

- A. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- B. Provide products that comply with requirements of NFPA 70 and NFPA 101.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
- F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- G. Recessed Luminaires:
 - 1. Ceiling Compatibility: Comply with NEMA LE 4.
 - 2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
- H. Hazardous (Classified) Location Luminaires: Listed and labeled as complying with UL 844 for the classification of the installed location.
- I. Fluorescent Luminaires:
 - 1. Provide ballast disconnecting means complying with NFPA 70 where required.
 - 2. Fluorescent Luminaires Controlled by Occupancy Sensors: Provide programmed start ballasts.
- J. LED Luminaires:
 - 1. Components: UL 8750 recognized or listed as applicable.
 - 2. Tested in accordance with IES LM-79 and IES LM-80.
 - 3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.
- K. Track Lighting Systems: Provide track compatible with specified track heads, with all connectors, power feed fittings, dead ends, hangers and canopies as necessary to complete installation.
- L. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

2.03 EMERGENCY LIGHTING UNITS

- A. Description: Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
- B. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps

to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.

- C. Battery:
 - 1. Size battery to supply all connected lamps, including emergency remote heads where indicated.
- D. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
- E. Provide low-voltage disconnect to prevent battery damage from deep discharge.

2.04 EXIT SIGNS

- A. Description: Exit signs and similar signs for special purpose applications such as area of refuge/rescue assistance.
- B. All Exit Signs: Internally illuminated with LEDs unless otherwise indicated; complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
 - 1. Number of Faces: Single or double as indicated or as required for the installed location.
 - 2. Directional Arrows: As indicated or as required for the installed location.

2.05 FLUORESCENT EMERGENCY POWER SUPPLY UNITS

- A. Description: Self-contained fluorescent emergency power supply units suitable for use with indicated luminaires, complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
- B. Compatibility:
 - 1. Ballasts: Compatible with electronic, standard magnetic, energy saving, and dimming AC ballasts, including those with end of lamp life shutdown circuits.
 - 2. Lamps: Compatible with low-mercury lamps.
- C. Operation: Upon interruption of normal power source, solid-state control automatically switches connected lamp(s) to the fluorescent emergency power supply for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.

2.06 LAMPS

- A. Manufacturers:
 - 1. GE Lighting: www.gelighting.com.
 - 2. Philips Lighting Co of NA: www.lighting.philips.com.
 - 3. Osram-Sylvania.
- B. Lamps - General Requirements:
 - 1. Unless explicitly excluded, provide new, compatible, operable lamps in each luminaire.
 - 2. Verify compatibility of specified lamps with luminaires to be installed. Where lamps are not specified, provide lamps per luminaire manufacturer's recommendations.
 - 3. Minimum Efficiency: Provide lamps complying with all current applicable federal and state lamp efficiency standards.
 - 4. Color Temperature Consistency: Unless otherwise indicated, for each type of lamp furnish products which are consistent in perceived color temperature. Replace lamps that are determined by the Engineer to be inconsistent in perceived color temperature.
- C. Linear Fluorescent Lamps: Wattage and bulb type as indicated, with base type as required for luminaire.
 - 1. Low Mercury Content: Provide lamps that pass the EPA Toxicity Characteristic Leaching Procedure (TCLP) test for characteristic hazardous waste.

2. T8 Linear Fluorescent Lamps:
 - a. Correlated Color Temperature (CCT): 4,100 K unless otherwise indicated.
 - b. Color Rendering Index (CRI): Not less than 85.
 - c. Average Rated Life: Not less than 20,000 hours for an operating cycle of three hours per start.
- D. Lamp Types: As specified for each fixture.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 16138 as required for installation of luminaires provided under this section.
- B. Install products according to manufacturer's instructions.
- C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship), NECA 500 (commercial lighting), and NECA 502 (industrial lighting).
- D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- E. Suspended Ceiling Mounted Luminaires:
 1. Do not use ceiling tiles to bear weight of luminaires.
 2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
 3. Secure surface-mounted and recessed luminaires to ceiling support channels or framing members or to building structure.
 4. Secure pendant-mounted luminaires to building structure.
 5. Secure lay-in luminaires to ceiling support channels using listed safety clips at two corners.
 6. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.
- F. Recessed Luminaires:
 1. Install trims tight to mounting surface with no visible light leakage.
- G. Suspended Luminaires:
 1. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
 2. Install canopies tight to mounting surface.
- H. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.
- I. Lighting in equipment rooms and electric closets is diagrammatic, indicating type, quantity and general circuiting of fixtures. Modify locations and mounting to suit conditions, allowing clearances for equipment, piping and ductwork.
- J. Install accessories furnished with each luminaire.
- K. Bond products and metal accessories to branch circuit equipment grounding conductor.
- L. Interface with air handling accessories.
- M. Exit Signs:
 1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.

- N. Fluorescent Emergency Power Supply Units:
 - 1. For field-installed units, install inside luminaire unless otherwise indicated. Where installation inside luminaire is not possible, install on top of luminaire.
 - 2. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal ballast(s) in luminaire. Bypass local switches, contactors, or other lighting controls.
- O. Remote Ballasts: Install in accessible location as indicated or as required to complete installation, using conductors per manufacturer's recommendations not exceeding manufacturer's recommended maximum conductor length to luminaire.
- P. Install lamps in each luminaire.

3.02 FIELD QUALITY CONTROL

- A. See Section 01400 - Quality Requirements, for additional requirements.
- B. Inspect each product for damage and defects.
- C. Operate each luminaire after installation and connection to verify proper operation.
- D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Engineer.
- E. New light fixtures SHALL NOT be used as temporary lighting. Once they are installed, test for proper installation, then leave off until ready to turn over to owner. Maintain temporary lighting throughout entire project.
- F. Any and all fluorescent lighting fixtures containing a dimming or step-dimming ballast shall have the lamp(s) burned-in at full brightness for 100 hours prior to any dimming.

3.03 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Engineer. Secure locking fittings in place.
- B. Aim and position adjustable emergency lighting unit lamps to achieve optimum illumination of egress path as required or as directed by Engineer or authority having jurisdiction.
- C. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Engineer or authority having jurisdiction.

3.04 CLEANING

- A. Clean surfaces according to NECA 500 (commercial lighting) and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

- A. Just prior to Substantial Completion, replace all lamps that have failed.

3.06 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

3.07 PROTECTION

- A. Relamp luminaires that have failed lamps at Substantial Completion.

3.08 SCHEDULE - SEE DRAWINGS

END OF SECTION

SECTION 16520
EXTERIOR LUMINAIRES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Exterior luminaires.
- B. Poles and accessories.

1.02 REFERENCE STANDARDS

- A. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; Illuminating Engineering Society; 2008.
- B. IES LM-80 - Approved Method: Measuring Lumen Maintenance of LED Light Sources; Illuminating Engineering Society; 2008.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- D. NECA/IESNA 501 - Recommended Practice for Installing Exterior Lighting Systems; 2006.
- E. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; National Electrical Manufacturers Association; 2012.
- F. NFPA 70 - National Electrical Code; National Fire Protection Association; 2002.
- G. UL 1598 - Luminaires; Current Edition, Including All Revisions.
- H. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate placement of poles and associated foundations with utilities, curbs, sidewalks, trees, walls, fences, striping, etc. installed under other sections or by others. Coordinate elevation to obtain specified foundation height.
 - 2. Notify Engineer of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.04 SUBMITTALS

- A. Provide photometric calculations where luminaires are proposed for substitution upon request.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, weight, effective projected area (EPA), and installed accessories; include model number nomenclature clearly marked with all proposed features.
 - 1. LED Luminaires:
 - a. Include estimated useful life, calculated based on IES LM-80 test data.
 - 2. Poles: Include information on maximum supported effective projected area (EPA) and weight for the design wind speed.
- C. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Receive, handle, and store products according to NECA/IESNA 501 and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.07 EXTRA MATERIALS

- A. Furnish one gallon of touch-up paint.

PART 2 PRODUCTS

2.01 LUMINAIRE TYPES

- A. Furnish products as indicated in Schedule included on the Drawings. For voluntary alternates, see Section 16010.

2.02 LUMINAIRES

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.
- F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- G. Provide luminaires listed and labeled as suitable for wet locations unless otherwise indicated.
- H. Recessed Luminaires:
 - 1. Ceiling Compatibility: Comply with NEMA LE 4.
 - 2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
- I. LED Luminaires:
 - 1. Components: UL 8750 recognized or listed as applicable.
 - 2. Tested in accordance with IES LM-79 and IES LM-80.
 - 3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

2.03 POLES

- A. Manufacturers: Furnish products as indicated in Schedule included on the Drawings. For voluntary alternates, see Section 16010.
- B. All Poles:
 - 1. Provide poles and associated support components suitable for the luminaire(s) and associated supports and accessories to be installed.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 16138 as required for installation of luminaires provided under this section.
- B. Install products according to manufacturer's instructions.
- C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship) and NECA/IESNA 501 (exterior lighting).

- D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- E. Recessed Luminaires:
 - 1. Install trims tight to mounting surface with no visible light leakage.
 - 2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
- F. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to bottom of luminaire, unless otherwise noted.
- G. Pole-Mounted Luminaires:
 - 1. Foundation-Mounted Poles:
 - a. Provide cast-in-place concrete foundations for poles as indicated, in accordance with Section 03300.
 - 1) Install anchor bolts plumb per template furnished by pole manufacturer.
 - 2) Position conduits to enter pole shaft.
 - b. Install foundations plumb.
 - c. Install poles plumb, using leveling nuts or shims as required to adjust to plumb.
 - d. Tighten anchor bolt nuts to manufacturer's recommended torque.
 - e. Install non-shrink grout between pole anchor base and concrete foundation, leaving small channel for condensation drainage.
 - 2. Grounding:
 - a. Bond luminaires, metal accessories, metal poles, and foundation reinforcement to branch circuit equipment grounding conductor.
 - 3. Install separate service conductors, 12 AWG copper, from each luminaire down to handhole for connection to branch circuit conductors.
- H. Install accessories furnished with each luminaire.
- I. Bond products and metal accessories to branch circuit equipment grounding conductor.

3.02 FIELD QUALITY CONTROL

- A. See Section 01400 - Quality Requirements, for additional requirements.
- B. Inspect each product for damage and defects.
- C. Operate each luminaire after installation and connection to verify proper operation.
- D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Engineer.

3.03 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Engineer. Secure locking fittings in place.
- B. Aim and adjust luminaires to provide illumination levels and distribution as directed.

3.04 CLEANING

- A. Clean surfaces according to NECA/IESNA 501 and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

3.06 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

3.07 SCHEDULE - SEE DRAWINGS

END OF SECTION

SECTION 16560
OCCUPANCY SENSOR LIGHTING CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Wall box mounted, wall/corner mounted, and ceiling mounted occupancy sensors including dual technology, ultrasonic, and passive infrared technologies. This includes self contained PIR sensors as well as low voltage sensors that work with Switchpacks.

1.02 REFERENCES

- A. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)
 - 1. C62.41-1991 – Recommended Practice for Surge Voltages in Low Voltage AC Power Circuits.
- B. ASTM International (ASTM)
 - 1. D4674 -02a Standard Test Method for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Fluorescent Lighting and Window-Filtered Daylight.
- C. Canadian Standards Association (CSA).
 - 1. CSA C22.2 # 14 Industrial Control Equipment
 - 2. CSA C22.2 # 184 Solid-State Lighting Controls
 - 3. CSA C22.2 # 156 Solid-State Speed Controls
- D. International Electrotechnical Commission.
 - 1. (IEC) 801-2 Electrostatic Discharge Testing Standard.
 - 2. IEC/EN 60669-2-1 Switches for household and similar fixed electrical installations - electronic switches.
- E. International Organization for Standardization (ISO)
 - 1. 9001:2000 – Quality Management Systems.
- F. National Electrical Manufacturers Association (NEMA)
 - 1. WD1 (R2005) - General Color Requirements for Wiring Devices.
- H. Underwriters Laboratories, Inc. (UL):
 - 1. 94 – Flammability Rating
 - 2. 916 – Energy Management Equipment.
 - 3. 508 (2005) - Standard for Industrial Control Equipment.
 - 4. 244A – Appliance Controls
 - 5. 935 (2005) - Fluorescent Ballasts

1.03 SYSTEM DESCRIPTION

- A. Permanently installed
 - 1. Wall switch occupancy sensors
 - 2. Ceiling mounted occupancy sensors
 - 3. Switchpacks

1.04 SUBMITTALS

- A. Submit under provisions of Section 013300.
- B. Specification Conformance Document: Indicate whether the submitted equipment:
 - 1. Meets specification exactly as stated.
 - 2. Meets specification via an alternate means and indicate the specific methodology used.

- C. Shop Drawings; include:
 - 1. Load schedule indicating actual connected load, load type, and voltage per circuit, circuits and their respective control zones, circuits that are on emergency, and capacity, phase, and corresponding circuit numbers.
 - 2. Schematic of system.
 - 3. Lighting plan clearly marking product type, location and orientation of each sensor.
- D. Product Data: Catalog specification sheets with performance specifications demonstrating compliance with specified requirements.

1.05 QUALITY ASSURANCE

- A. Manufacturer: Minimum 20 years' experience in manufacture of occupancy sensor lighting controls.
- B. Manufacturer's Quality System: Registered to ISO 9001:2000 Quality Standards, including in-house engineering for product design activities.
- C. Occupancy Sensing Lighting Controls:
 - 1. Listed by UL specifically for the required loads. Provide evidence of compliance upon request.
- D. Installer Qualifications: Installer shall be one who is experienced in performing the work of this section, and who has specialized in installation of work similar to that required for this project.
- E. Source Limitations: To assure compatibility, obtain occupancy sensors from a single source with complete responsibility over all lighting controls, including accessory products. The use of subcontracted component assemblers is not acceptable.

1.06 PROJECT CONDITIONS

- A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
 - 1. Ambient temperature: 0° to 40° C (32° to 104° F).
 - 2. Relative humidity: Maximum 90 percent, non-condensing.
 - 3. Occupancy Sensors must be protected from dust during installation.

1.07 WARRANTY

- A. Provide manufacturer's 5-year parts warranty.

1.08 MAINTENANCE

- A. Make ordering of new equipment for expansions, replacements, and spare parts available to end user.
- B. Make new replacement parts available for minimum of ten years from date of manufacture.
- C. Provide factory direct technical support.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers: Eaton Lighting Systems (formerly Cooper Controls), Sensor Switch, Wattstopper, or HBA.
- B. Substitutions:
 - 1. All proposed substitutions (clearly delineated as such) must be submitted in writing for approval by the design professional a minimum of 10 working days prior to the bid date and must be made available to all bidders.
 - 2. Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis.
 - 3. By using pre-approved substitutions, the contractor accepts responsibility and associated costs for all required modifications to circuitry, devices, and wiring.

4. Provide complete engineered shop drawings (including power wiring) with deviations for the original design highlighted in an alternate color to the engineer for review and approval prior to rough-in.
5. Voluntary alternates can be submitted per Section 16010.

2.02 SENSOR PERFORMANCE REQUIREMENTS

- A. Sensing mechanism:
 1. Infrared: Utilize multiple segmented lens, with internal grooves to eliminate dust and residue build-up.
 2. Ultrasonic:
 - a. Utilize an operating frequency of 32 kHz or 40 kHz that shall be crystal controlled to operate within plus or minus 0.005% tolerance.
 - b. Utilize Doppler shift ultrasonic detection technology.
 3. Dual technology:
 - a. Utilize multiple segmented lens, with internal grooves to eliminate dust and residue build-up.
 - b. Utilize an operating frequency of 32 kHz or 40 kHz that shall be crystal controlled to operate within plus or minus 0.005% tolerance.
 - c. Incorporate Doppler shift ultrasonic and passive infrared motion detection technologies. Products that react to noise or ambient sound shall not be considered.
- B. Power failure memory:
 1. Controls incorporate non-volatile memory. Should power be interrupted and subsequently restored, settings and parameters saved in protected memory shall not be lost.
- C. Designed and tested to withstand discharges without impairment of performance when subjected to discharges of 15,000 volts per IEC 801-2.
- D. Products tested in identical manner, complaint to NEMA WD 7 -2011 Occupancy Motion Sensors Standards.
- E. Sensor shall have time delays from 10 to 30 min.
- F. When specified, sensors shall automatically adjust time delay and sensitivity settings.
- G. All sensors shall provide an LED as a visual means of indication at all times to verify that motion is being detected during both testing and normal operation.
- H. All sensors shall have readily accessible, user adjustable settings for time delay and sensitivity. Settings shall be located on the sensor (not the control unit) and shall be recessed to limit tampering.
- I. Where specified, sensor shall have an internal additional isolated relay with Normally Open, Normally Closed, and Common outputs for use with HVAC control, Data Logging and other control options. Sensors utilizing separate components or specially modified units to achieve this function are not acceptable.

2.03 LOW VOLTAGE CEILING MOUNTED VACANCY/OCCUPANCY SENSORS

- A. Provide all necessary mounting hardware and instructions.
- B. Sensors shall be Class 2 devices.
- C. When requested, be able to provide customizable mask to block off unwanted viewing areas for all ceiling mounted sensors using infrared technology.
- D. Provide an internal additional isolated relay with Normally Open, Normally Closed and Common outputs for use with HVAC control, Data Logging and other control options.

2.04 LOW VOLTAGE CEILING MOUNTED OCCUPANCY SENSORS

- A. Provide all necessary mounting hardware and instructions.
- B. Sensors shall be Class 2 devices.

- C. When requested, be able to provide customizable mask to block off unwanted viewing areas for all ceiling mounted sensors using infrared technology.
- D. Provide an internal additional isolated relay with Normally Open, Normally Closed and Common outputs for use with HVAC control, Data Logging and other control options.

2.05 WALL / CORNER MOUNTED SENSORS

- A. Provide all necessary mounting hardware and instructions.
- B. Sensors shall be Class 2 devices.
- C. Where specified, sensors shall offer daylighting footcandle adjustment control
- D. Where specified, sensor packaging shall be 100% recycled [made entirely from post consumer waste (100% post consumer fiber content) as well as, 100% recyclable].
- E. Sensors shall be RoHS compliant.
- F. Where specified, sensors shall offer integral Bi-level Automatic On (just one lighting level comes on automatically when occupancy is detected)

2.06 VACANCY WALL SWITCHES

- A. Requires Manual On to activate lighting.
- B. Cannot be modified to provide Automatic ON capabilities.
- C. Provide a mechanical air-gap on/off function for all sensors.
- D. Capable of detection of occupancy at desktop level up to 300 square feet, and gross motion up to 1000 square feet
- E. Shall accommodate loads from 0-800 watts at 120 volts; 0 to 1200 watts at 277 volts and shall have 180 degree coverage capability.
- F. Shall be able to have their visible plastic parts replaced, for color changes in the field, without removing the body of the control from the wall and without requiring special tools.
- G. Shall utilize Zero Crossing Circuitry which increases relay life, protects from the effects of inrush current, and increases sensor's longevity.
- H. Shall have no leakage current to load, in manual or in Auto/Off Mode for safety purposes and shall have voltage drop protection.
- I. Where specified, wall switch sensors shall provide a field selectable option to convert sensor operation from Automatic On to Manual On.
- J. Where specified, sensors shall offer daylighting foot-candle adjustment control and be able to accommodate dual level lighting.
- K. Where specified, dual relay sensors shall offer daylighting foot-candle adjustment control for either or both relays.
- L. Where specified, dual relay sensors shall offer a Bathroom Mode which keeps the second relay On for an addition 8 minutes after the first relay has been turned off.
- M. Where specified, sensors shall feature a universally recognized light bulb icon for end user ease of identification of use.
- N. Where specified, dual relay sensors shall feature universally recognized light bulb and fan icons for end user ease of identification of use.
- O. Where specified, sensor packaging shall be 100% recycled [made entirely from post-consumer waste (100% post-consumer fiber content) as well as, 100% recyclable].
- P. Sensors shall be RoHS compliant.
- Q. Where specified, sensors shall have an EcoMeter that provides a visual indicator of energy usage, increasing end user awareness and reminding individuals to take control of their lighting to maximize energy savings.

- R. Where specified, low voltage sensors shall have a Tracking/HVAC Mode that allows the load connected to the Form C BAS relay to remain on when the lights are turned off manually.
- S. Where specified, sensors shall have a tamper-proof Automatic Only Mode that automatically turns lighting ON and OFF without requiring a user to push a button.

2.07 OCCUPANCY WALL SWITCHES

- A. Provide a mechanical air-gap on/off function for all sensors.
- B. Capable of detection of occupancy at desktop level up to 300 square feet, and gross motion up to 1000 square feet
- C. Shall accommodate loads from 0-800 watts at 120 volts; 0 to 1200 watts at 277 volts and shall have 180 degree coverage capability.
- D. Shall be able to have their visible plastic parts replaced, for color changes in the field, without removing the body of the control from the wall and without requiring special tools.
- E. Shall utilize Zero Crossing Circuitry which increases relay life, protects from the effects of inrush current, and increases sensor's longevity.
- F. Shall have no leakage current to load, in manual or in Auto/Off Mode for safety purposes and shall have voltage drop protection.
- G. Where specified, wall switch sensors shall provide a field selectable option to convert sensor operation from Automatic On to Manual On.
- H. Where specified, sensors shall offer daylighting footcandle adjustment control and be able to accommodate dual level lighting.
- I. Where specified, dual relay sensors shall offer daylighting footcandle adjustment control for either or both relays.
- J. Where specified, dual relay sensors shall offer a Bathroom Mode which keeps the second relay On for an addition 8 minutes after the first relay has been turned off.
- K. Where specified, sensors shall feature a universally recognized light bulb icon for end user ease of identification of use.
- L. Where specified, dual relay sensors shall feature universally recognized light bulb and fan icons for end user ease of identification of use.
- M. Where specified, sensor packaging shall be 100% recycled [made entirely from post consumer waste (100% post consumer fiber content) as well as, 100% recyclable].
- N. Sensors shall be RoHS compliant.
- O. Where specified, sensors shall have an EcoMeter that provides a visual indicator of energy usage, increasing end user awareness and reminding individuals to take control of their lighting to maximize energy savings.
- P. Where specified, low voltage sensors shall have a Tracking/HVAC Mode that allows the load connected to the Form C BAS relay to remain on when the lights are turned off manually.
- Q. Where specified, sensors shall have a tamper-proof Automatic Only Mode that automatically turns lighting on and off without requiring a user to push a button.

2.08 SENSOR SWITCHPACKS

- A. Control wiring between sensors and control units shall be Class 2, 18-24 AWG, stranded U.L. Classified, PVC insulated or TEFLON jacketed cable suitable for use in plenums.
- B. Integrated, self-contained unit consisting internally of an isolated load switching control relay and a power supply to provide low voltage power.
- C. Shall be compatible with incandescent, magnetic or electronic low voltage, and magnetic or electronic fluorescent, as well as motor loads.

2.10 SOURCE QUALITY CONTROL

- A. Perform full-function testing on 100% of all system components and panel assemblies at the factory.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install equipment in accordance with manufacturer's installation instructions.
- B. Provide complete installation of system in accordance with Contract Documents.
- C. Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.

3.02 TESTING

- A. Upon completion of all wiring and after all fixtures are installed and lamped, a representative shall check the installation prior to energizing the system. Each installed occupancy sensor shall be tested in the Test Mode to see that lights turn OFF and on based on occupancy.
- B. At the time testing, the owner's representative shall be thoroughly instructed in the proper operation of the system.

END OF SECTION

SECTION 16570
RELAY LIGHTING CONTROLS

PART 1 - GENERAL

1.01 INTRODUCTION

- A. The work covered in this section is subject to all of the requirements in the General Conditions of the specifications.
- B. Contractor shall coordinate all of the work in this section with all the trades covered in the other sections of the specification to provide a complete and operative system.

1.02 DESCRIPTION OF WORK

- A. Extent of lighting control system work is indicated by drawings, and by the requirements of this section. It is defined to include low voltage lighting control panels, switch inputs, and wiring.
- B. Type of lighting control equipment and wiring specified in this section include the following:
 - 1. Relay Lighting Control Panels

1.03 QUALITY ASSURANCE

- A. UL & ULc Approvals
 - 1. The control panels shall be tested and listed under the UL 916 Energy Management Equipment standard and CSA C22.2 #205 by a nationally recognized testing laboratory.
- B. NEC COMPLIANCE
 - 1. The control system shall comply with all applicable National Electrical Codes regarding electrical wiring standards.
- C. NEMA COMPLIANCE
 - 1. The control system shall comply with all applicable portions of the NEMA standards regarding the types of electrical equipment enclosures.
- D. COMPONENT PRE-TESTING
 - 1. All control equipment shall undergo strict inspection standards. The equipment shall be previously tested and burned-in at the factory prior to installation.
- E. SYSTEM CHECKOUT
 - 1. A factory trained technician or factory authorized personnel or contractor shall functionally test the control system and verify performance after installation.

1.04 SUBMITTALS

- A. Product Data
 - 1. Submit manufacturer's data on lighting control system and components.
- B. SHOP DRAWINGS
 - 1. Submit drawings of lighting control panel and accessories including, but not necessarily limited to the low voltage relay panels, power wiring, and switch inputs.

PART 2 - PRODUCTS

2.01 MATERIALS AND COMPONENTS

- A. SYSTEM DESCRIPTION
 - 1. The lighting control system shall consist of low voltage relay control panels with 64 programmable switch inputs and shall offer up to 32 control relays.
 - 2. Each low voltage lighting control panel shall be microprocessor controlled. Programming shall be accomplished through either the RS-232 port or through the network connection employing the keeper enterprise software or with an integral 4 x 16 – 64 character self-prompting LCD display and programming keypad.

3. Programmable intelligence shall include time-of-day control, 32 holiday dates, warn occupants of an impending off, timed inputs, preset control, auto daylight savings, astronomical clock w/offsets, and local control, digital switches and network overrides.
 - a. Time of Day 64 Time-Of-Day/holiday schedules for 365 day programming
 - b. Holidays 32 holiday dates
 - c. Warn Off Flash lights and provide an extra 1 second to 99 minutes of illumination
 - d. Preset Pre-programmed switch patterns
 - e. Timed Inputs Switch input timers 1-999 minutes
 - f. Timed Overrides Timed override 1-999 minutes, resumes to normal schedule
 - g. Local Control From keypad & LCD display or local switch
 - h. Astronomical Clock Longitude and latitude input with sunset-sunrise offsets to customize outdoor lighting
 - i. Auto Daylight Savings Adjust. Automatically adjusts the clock at the appropriate dates, selectable
 - j. Priorities Establishes a hierarchy for inputs and network control commands
 - k. Masking Provides permission orientation to switch inputs and network commands thereby ensuring building lighting control integrity.
 - l. Soft-Linking Group linking for rapid programming
 - m. Global Linking Each panel shall provide 64 addressable groups for network linking of control commands

- B. Relays may be designated as either normally open or normally closed from the software. Relay status shall not only disclose commanded relay status but next scheduled state to occur.
- C. Each control panel shall provide a Warn Off (flash the lights) to inform the occupants of an impending Off command. The Warn Off command shall provide an adjustable time duration of 1 second to 99 extra minutes. The occupants may exit the premises with adequate lighting or cancel the Warn Off by overriding the lighting zone. This option occurs with all Off commands except local overrides.
- D. The controller shall permit lighting to be overridden on for after hours use or cleaning. The controller shall provide optional switch timer assignments or timed overrides. The override choices for various relays shall provide special event occurrences and the controller shall return to the programmed state after the override event. Also, the controller shall provide priority and masking choices to customize the functions of switch inputs, thereby enabling switches to function differently at different times of the day to meet special facility operational requirements. These overrides shall be digital, or hard-wired inputs.
- E. Programming the controller shall be through the RS-232 port or through the network connection. Communication to the panel can be accomplished via, RS-232, modem, or TCP/IP. Programming the controller shall also be accomplished through the integral keypad and LCD display. Descriptive information shall assist the user to employ the system with a programming manual. Lighting control systems that utilize removable programming keypads shall not be acceptable.

- F. Priorities and/or masking shall be assigned to inputs, telephone override, and global commands to insure building integrity. Priorities enable or disable the inputs based on user actuation of overrides. Masks shall permit: on only, off only and on & off control for intelligent after hours utilization of the controlled facility based on time-of-day scheduling in the controller.
- G. The lighting control system shall log all control events. The controller shall monitor all relay actuations, switch inputs and user intervention. Log reports shall be available for any duration of time the operator chooses through the keeper enterprise software. Runtimes for each relay shall be available from the keeper enterprise software.

PART 3 - HARDWARE FEATURES

3.01 DIAGNOSTIC AIDS

- A. Each control panel shall incorporate diagnostic aids for confirmation of proper operation, or in case of failure these aids shall guide the individual in rapid troubleshooting of the system.
- B. The control panels shall employ both a backlit LCD and LED's to indicate:
 - 1. POWER (LED)
 - 2. SYSTEM OK (LED)
 - 3. ON/OFF STATUS of EACH RELAY (LED & LCD)
 - 4. SYSTEM CLOCK AND DATE (LCD)
 - 5. PROGRAMMING CONFIRMATION (LCD)
- C. Control systems that do not provide visual self-help diagnostics shall not be acceptable.
 - 1. a. Status Indication of Relays
 - 2. The system shall provide visible status indication of all relays through the window of each control panel. The visual indication shall disclose On/Off status and relay number. Systems that do not provide relay status while the enclosure door is closed shall not be acceptable.

3.02 OPERATOR INTERFACE

- A. The control panel programming interface resides in firmware in the control panel. The programming interface shall consist of a circuit board mounted keypad and 4 line x 16 character LCD display. The integral keypad shall provide access to the main programming features. The keypad shall permit the user to manually command any or all relays individually. It shall also allow the user to link switch inputs and time schedules to relay outputs. Each panel shall control its own loads from internal memory. A control system that relies on a central control computer/processor or external time clocks shall not be permitted. Systems that utilize blocking diode technology for relay assignments shall not be acceptable.

3.03 OVERRIDES

- A. The controller shall provide timers for each override. Each override timer shall be capable of 0-999 minutes. Software shall enable or disable overrides based on Priorities, Masks or Time Of Day scheduling.
 - 1. Digital Switch
 - 2. The lighting controller shall support digitally addressable LED annunciated switches. The maximum total number of digital switches that may exist on the lighting control network is 16,320. Each Subnet shall support 64 buttons. The digital switch network requires CAT 5 cable between switches. The digital switches shall control any relay group combination in the panel. Data communications status feedback for system checkout and troubleshooting (transmit and receive —> LED'S) shall be visible on both the controller and interface.
 - 3. The digital switch configuration system shall permit custom labeling for multiple button switch locations. The digital switch configuration shall be Decora® form and function.
 - 4. Dry Contact Inputs

5. The control system shall permit 32 dry contacts inputs for override purposes. Momentary 3 wire or 2 wire (toggle) inputs shall be supported. Maintained contacts shall be supported as 2 wire (SPST) inputs. Inputs shall be dry contacts (24 VDC @ 12 ma. internally supplied to the inputs). The 24 VDC power supply is provided with an auto-resettable fuse. Should an inappropriate electrical connection be made the design will protect the board and switches until the fault is removed. Any switch input shall be software linked to any number of relays for override control. The control panel shall have dry contact inputs on the logic board. Control systems that utilize separate accessories to allow for dry contact switches shall not be acceptable. Control systems that do not supply both digital switches and analog switches from the same controller shall not be permitted.
6. PhotoCell Control
7. The controller shall accept dry contact ambient light sensors. The controller shall provide power for the sensor thereby eliminating any external power supply. Sensors shall provide for outdoor and indoor applications and issue a command to the controller once the threshold is reached. The sensor shall provide user adjustable dead band control.
8. Remote Overrides
9. The controller shall accept remote commands issued from other inputs. The controller shall provide this feature without the need to add extra equipment to the controller. Remote overrides can be issued from the Telephone Interface Module (TIM), Photocells, Motion Sensors, Digital or Dry Contact Switches. Lighting systems that need to add extra equipment to receive remote overrides are not acceptable.

3.04 SERVICE OVERRIDE & PRIORITY OVERRIDE

- A. The control panel shall provide a three position master-service override for the control unit. The service override shall not be accessible from the exterior. Systems that provide a service override on the exterior of the controller shall not be acceptable.
- B. The master service override provides a single three-position switch with the option of All Off, Auto, and All On, respectively. This master switch shall operate all of the relays in the controller. This switch shall override and supersede all commands from the logic board when the switch is in the All On or All Off position. The master switch shall function to override all the relays should the logic board programming differ from the space function.
- C. The system shall remember the last command to the individual relays. Upon returning the master override switch to the Auto position, the relays shall return to the most recent command state. This will occur even if the last command happened during the master override condition.

3.05 RELAYS

- A. Standard with electrically held 20amp 120/277VAC relays. Relays must be specified Normally Open or Normally Closed. The relays shall be rated for 10 million mechanical operations. Select from the Relay Output Options which additional relays will be utilized in the LiteKeeper® controller for your application.
 1. Two Pole Relay Card (TPRC)
 - a. The controller shall provide an option for two pole relay control. The Two Pole Relay Card TPRC shall offer the feature of controlling two pole voltages such as 208, 240, and 480 VAC lighting loads at 20 amps. The relays shall be modular in design and offer manual hand override control. This optional relay card shall also provide a visual indication of relay status. The 208, 240 VAC version shall provide 8 relays per card whereas the 480 VAC version shall provide 4 relays per card. Combinations of relays shall be permitted since relays shall snap into location.
 2. Latching Relay Card (LRC)
 - a. The controller shall provide an option to provide latching relays that are rated to 20 amps at 347 VAC. The relay shall provide an integral switch for both manual hand operation and visual indication of relay status. The relays shall be rated for 10 million

mechanical operations. The wire terminations shall be able to accept 6 AWG wire. A limited 10-year warranty shall be provided on the individual relays. Systems that do not offer a limited 10-year warranty on all installations are not acceptable.

3. High Voltage Barriers
 - a. The controller shall provide as an option the ability to provide a barrier for either voltage separation or emergency circuit separation. The 16-size enclosure shall permit one barrier and the 32-size enclosure shall permit up to three locations and the 48-size shall provide 5 locations where the barrier(s) may be installed. The barrier shall be painted red to denote the difference. Systems that do not provide voltage separation are not acceptable.

3.06 RS-232 PORT

- A. The controller shall provide an RJ-12 connection for RS-232 communications. Programming shall be permitted through either a local connection or remotely through a modem. The Keeper Enterprise software accessory includes a six wire communication cable to connect to the controller. Systems that do not include an on-board RS-232 port for communications are not acceptable.

3.07 MODULAR DESIGN

- A. The control system shall employ all modular connectors to avoid repeat wiring in case of component failure. The system CPU board shall be on quick release hinge pins that shall permit an entire change out of the processor and input board in less than 1 minute.
- B. All connections for the switch inputs shall incorporate modular connectors. The relay board shall be modular and designed for rapid field replacement or upgrading. Systems that do not employ modular connectors shall not be acceptable.

3.08 MEMORY BACK-UP

- A. The system shall utilize a memory back-up device that is system integrated and shall be non-serviceable. The data in RAM shall be protected against power interruptions lasting as long as 7 days. The power interrupt protection circuit shall be entirely maintenance-free.

3.09 MULTI-TAPPED TRANSFORMER

- A. The control panel shall incorporate the use of a multi-tapped transformer. The panel shall not require specification of voltage for each control location. The voltages of 120 & 277 VAC shall be available with each control panel.

3.10 LOCKABLE ENCLOSURE

- A. Each control panel shall be enclosed in a lockable NEMA class 1 enclosure. The enclosure shall be manufactured out of 1/16" steel and shall provide pre-punched knockouts for efficient installation.
- B. The low voltage controller shall exist in two sizes of relay enclosures. The enclosure maximum sizes shall be either 16 or 32 relays per cabinet. The 16 size will employ two relays cards and the 32 will utilize 4 relay cards. Relays shall be provided in groups of eight relays per card.

PART 4 EXECUTION

4.01 EQUIPMENT INSTALLATION AND DOCUMENTATION

- A. The control system shall be installed and fully wired as shown on the plans by the installing contractor. The contractor shall complete all electrical connections to all control circuits, and override wiring.
- B. The contractor shall provide accurate "as-built" drawings to the owner for correct programming and proper maintenance of the control system. The "as-builts" shall indicate the load controlled by each relay and the relay panel number.

4.02 OPERATION AND SERVICE MANUALS

- A. The contractor shall obtain and deliver all operation and service manuals from the factory to the Owner.

4.03 PRODUCT SUPPORT AND SERVICE

- A. Factory telephone support shall be available at no cost to the owner. Factory assistance shall consist of solving programming or application questions concerning the control equipment.

4.04 SYSTEM DELIVERY AND ACCEPTANCE

- A. The contractor is responsible for complete installation of the entire system according to strict factory standards and requirements. The following items shall constitute factory standards and requirements:
 - 1. All system equipment shall operate in accordance with specification and industrial standard procedures.
 - 2. An operational user program shall exist in the control system. The program shall execute and perform all functions required to effectively operate the site according to the requirements.
 - 3. Demonstration of program integrity during normal operation and pursuant to a power outage.
 - 4. Contractor shall provide a minimum of two training hours on the operation and use of the control system. Additional support services shall be negotiated between the contractor and the building owner or manager.

4.05 WARRANTY

- A. Manufacturer shall supply a 3-year warranty on all hardware and software. A limited 10-year warranty shall be provided on all relay cards. These warranties will be in effect for all installations. Systems that provide special warranties based on installation shall not be acceptable.

END OF SECTION

SECTION 16700
FIRE ALARM SIGNAL AND MASS NOTIFICATION SYSTEM

PART 1 GENERAL

1.01 SUMMARY

- A. This Section covers fire alarm systems, including initiating devices, notification appliances, controls, and supervisory devices.
- B. Work covered by this section includes the furnishing of labor, equipment, and materials for installation of the fire alarm system as indicated on the drawings and specifications.
- C. The Fire Alarm System shall consist of all necessary hardware equipment and software programming to perform the following functions:
 - 1. Fire alarm and detection operations
 - 2. Control and monitoring of elevators, smoke control equipment, door hold-open devices, fire suppression systems, emergency power systems, and other equipment as indicated in the drawings and specifications.
 - 3. One-way supervised automatic voice alarm operations.
- D. **The installing company shall prepare and submit appropriate plans and documentation for fire alarm system plan review(s) to the Authority(ies) Having Jurisdiction. All associated plan review fees shall be included.**

1.02 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: The equipment and service described in this specification are those supplied and supported by Simplex for the equipment.
- B. Being listed as an acceptable Manufacturer in no way relieves obligation to provide all equipment and features in accordance with these specifications.
- C. The Manufacturer shall be a nationally recognized company specializing in fire alarm and detection systems. This organization shall employ factory trained NICET certified technicians, and shall maintain a service organization within 100 miles of this project location. The Manufacturer and service organization shall have a minimum of 10 years experience in the fire protective signaling systems industry.

1.03 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.
- B. The work covered by this section is to be coordinated with related work as specified elsewhere in the specifications. Requirements of the following sections apply:
 - 1. Division 16: "Basic Electrical Materials and Methods."
 - 2. Division 16: "Wiring Methods."
 - 3. Division 15: "Fire Protection"
 - 4. Division 15: "HVAC Systems"
- C. The system and all associated operations shall be in accordance with the following:
 - 1. Guidelines of the following Building Code: MBC
 - 2. NFPA 72, National Fire Alarm Code
 - 3. NFPA 70, National Electrical Code
 - 4. NFPA 101, Life Safety Code
 - 5. Other applicable NFPA standards
 - 6. Local Jurisdictional Adopted Codes and Standards
 - 7. ADA Accessibility Guidelines

1.04 SYSTEM DESCRIPTION

- A. General: Provide a complete, non-coded, addressable, microprocessor-based fire alarm system with initiating devices, notification appliances, and monitoring and control devices as indicated on the drawings and as specified herein.

- B. Software: The fire alarm system shall allow for loading and editing instructions and operating sequences as necessary. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory.
- C. History Logs: The system shall provide a means to recall alarms and trouble conditions in chronological order for the purpose of recreating an event history. A separate alarm and trouble log shall be provided.
- D. Recording of Events: Record all alarm, supervisory, and trouble events by means of system printer. The printout shall include the type of signal (alarm, supervisory, or trouble) the device identification, date and time of the occurrence. The printout differentiates alarm signals from all other printed indications.
- E. Wiring/Signal Transmission:
 - 1. Transmission shall be addressable signal transmission, dedicated to fire alarm service only.
 - 2. System connections for initiating (signaling) circuits and notification appliance circuits shall be Class B.
 - 3. Circuit Supervision: Circuit faults shall be indicated by a trouble signal at the FACP. Provide a distinctive indicating audible tone and alphanumeric annunciation.
- F. Remote Access:
 - 1. FACP shall have the capability to provide Remote Access through a Dial-Up Service Modem using the public switched telephone system of a private switched telephone system.
 - 2. A personal computer or technician's laptop, configured with terminal emulation software shall have the ability to access the FACP for diagnostics, maintenance reporting and information gathering.
- G. Required Functions: The following are required system functions and operating features:
 - 1. Priority of Signals: Alarm events have highest priority. Subsequent alarm events are queued in the order received and do not affect existing alarm conditions. Priority Two, Supervisory and Trouble events have second-, third-, and fourth-level priority respectively. Signals of a higher-level priority take precedence over signals of lower priority even though the lower-priority condition occurred first. Annunciate all events regardless of priority or order received.
 - 2. Noninterfering: The activation of an addressable device does not prevent the receipt of signals from subsequent activations.
 - 3. Transmission to Remote Central Station: Automatically route alarm, supervisory, and trouble signals to a remote central station service transmitter provided under another contract.
 - 4. Annunciation: Operation of alarm and supervisory initiating devices shall be annunciated at the FACP, indicating the location and type of device.
 - 5. General Alarm: A system general alarm shall include:
 - a. Indication of alarm condition at the FACP.
 - b. Identification of the device that is the source of the alarm at the FACP.
 - c. Operation of audible and visible notification devices throughout the building until silenced at FACP.
 - d. Closing doors normally held open by magnetic door holders.
 - e. Unlocking designated doors.
 - f. Shutting down supply and return fans serving zone where alarm is initiated.
 - g. Closing smoke dampers on system serving zone where alarm is initiated.
 - h. Notifying the local fire department.
 - i. Initiation of elevator recall in accordance with ASME/ANSI A17.1, when specified detectors are activated.

6. Supervisory Operations: Upon activation of a supervisory device such as fire pump power failure, low air pressure switch, and tamper switch, the system shall operate as follows:
 - a. Activate the system supervisory service audible signal and illuminate the LED at the control unit and the graphic annunciator.
 - b. Pressing the Supervisory Acknowledge Key will silence the supervisory audible signal while maintaining the Supervisory LED "on" indicating off-normal condition.
 - c. Record the event in the FACP historical log.
 - d. Transmission of supervisory signal to remote central station.
 7. Restoring the condition shall cause the Supervisory LED restore system to normal.
 8. Alarm Silencing: If the "Alarm Silence" button is pressed, all audible alarm signals shall cease operation.
 9. System Reset
 - a. The "System Reset" button shall be used to return the system to its normal state. Display messages shall provide operator assurance of the sequential steps ("IN PROGRESS", "RESET COMPLETED") as they occur. The system shall verify all circuits or devices are restored prior to resetting the system to avoid the potential for re-arming the system. The display message shall indicate "ALARM PRESENT, SYSTEM RESET ABORTED."
 - b. Should an alarm condition continue, the system will remain in an alarmed state.
 10. Drill: A manual evacuation (drill) switch shall be provided to operate the notification appliances without causing other control circuits to be activated.
 11. WALKTEST: The system shall have the capacity of 8 programmable passcode protected one person testing groups, such that only a portion of the system need be disabled during testing. The actuation of the "enable one person test" program at the control unit shall activate the "One Person Testing" mode of the system as follows:
 - a. The city circuit connection and suppression release circuits shall be bypassed for the testing group.
 - b. Control relay functions associated to one of the 8 testing groups shall be bypassed.
 - c. The control unit shall indicate a trouble condition.
 - d. The alarm activation of any initiation device in the testing group shall cause the audible notification appliances to sound a voice announcement to identify the device.
 - e. The unit shall automatically reset itself after signaling is complete.
 - f. Any momentary opening of an initiating or notification appliance circuit wiring shall cause the audible signals at the control panel indicating the trouble condition.
- H. Analog Smoke Sensors:
1. Monitoring: FACP shall individually monitor sensors for calibration, sensitivity, and alarm condition, and shall individually adjust for sensitivity. The control unit shall determine the condition of each sensor by comparing the sensor value to the stored values.
 2. Environmental Compensation: The FACP shall maintain a moving average of the sensor's smoke chamber value to automatically compensate for dust, dirt, and other conditions that could affect detection operations.
 3. Programmable Sensitivity: Photoelectric Smoke Sensors shall have 7 sensitivity levels ranging from 0.2% to 3.7%, programmed and monitored from the FACP.
 4. Sensitivity Testing Reports: The FACP shall provide sensor reports that meet NFPA 72 calibrated test method requirements.
 5. The FACP shall automatically indicate when an individual sensor needs cleaning. The system shall provide a means to indicate that a sensor requires cleaning. When a sensor's average value reaches a predetermined value, (3) progressive levels of reporting are provided. The first level shall indicate that a sensor is close to a trouble reporting condition and will be indicated on the FACP as "ALMOST DIRTY." This condition provides a means to alert maintenance staff of a dirty sensor without creating a trouble in the system. If this indicator is ignored, a second level "DIRTY SENSOR" condition shall be indicated at the FACP and subsequently a system trouble is reported [to the Central Monitoring Station]. The sensor base LED shall glow steady giving a visible indication at the sensor location.

The "DIRTY SENSOR" condition shall not affect the sensitivity level required to alarm the sensor. If a "DIRTY SENSOR" is left unattended, and its average value increases to a third predetermined value, an "EXCESSIVELY DIRTY SENSOR" trouble condition shall be indicated at the control unit.

6. The FACP shall continuously perform an automatic self-test on each sensor which will check sensor electronics and ensure the accuracy of the values being transmitted. Any sensor that fails this test shall indicate a "SELF TEST ABNORMAL" trouble condition.]
- I. Fire Suppression Monitoring:
 1. Water flow: Activation of a water flow switch shall initiate general alarm operations.
 2. Sprinkler valve tamper switch: The activation of any valve tamper switch shall activate system supervisory operations.
- J. Audible Alarm Notification: By voice evacuation and tone signals on loudspeakers in areas as indicated on drawings.
 1. Automatic Voice Evacuation Sequence:
 - a. The audio alarm signal shall consist of an alarm tone for a maximum of five seconds followed by an automatic digital voice message. At the end of the voice message, the alarm tone shall resume. This sequence shall sound continuously until the "Alarm Silence" switch is activated.
 - b. All audio operations shall be activated by the system software so that any required future changes can be facilitated by authorized personnel without any component rewiring or hardware additions.
- K. Manual Voice Paging
 1. The system shall be configured to allow voice paging. Upon activation of any speaker manual control switch, the alarm tone shall be sounded over all speakers in that group.
 2. The control panel operator shall be able to make announcements via the push-to-talk paging microphone over the pre-selected speakers.
 3. Facility for total building paging shall be accomplished by the means of an "All Call" switch.
- L. Power Requirements
 1. The control unit shall receive 120 VAC power via a dedicated fused disconnect circuit.
 2. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of 24 hours with 5 minutes of alarm operation at the end of this period. The system shall automatically transfer to battery standby upon power failure. All battery charging and recharging operations shall be automatic.
 3. All circuits requiring system-operating power shall be 24 VDC and shall be individually fused at the control unit.
 4. The incoming power to the system shall be supervised so that any power failure will be indicated at the control unit. A green "power on" LED shall be displayed continuously while incoming power is present.
 5. The system batteries shall be supervised so that a low battery condition or disconnection of the battery shall be indicated at the control unit.
 6. The system shall support 100% of addressable devices in alarm or operated at the same time, under both primary(AC) and secondary (battery) power conditions.
 7. Loss of primary power shall sound a trouble signal at the FACP. FACP shall indicate when the system is operating on an alternate power supply.

1.05 SUBMITTALS

- A. General: Submit the following according to Conditions of Contract and Division 1 Specification Sections.
 1. Product data sheets for system components highlighted to indicate the specific products, features, or functions required to meet this specification. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification.

2. Wiring diagrams from manufacturer.
 3. Shop drawings showing system details including location of FACP, all devices, circuiting.
 4. System Power and battery charts with performance graphs and voltage drop calculations to assure that the system will operate per the prescribed backup time periods and under all voltage conditions per UL and NFPA standards.
 5. System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. A list of all input and output points in the system shall be provided with a label indicating location or use of IDC, NAC, relay, and auxiliary control circuits.
 6. Operating instructions for FACP.
 7. Operation and maintenance data for inclusion in Operating and Maintenance Manual. Include data for each type product, including all features and operating sequences, both automatic and manual. Provide the names, addresses, and telephone numbers of service organizations.
 8. Product certification signed by the manufacturer of the fire alarm system components certifying that their products comply with indicated requirements.
 9. Record of field tests of system.
- B. Submission to Authority Having Jurisdiction: In addition to routine submission of the above material, make an identical submission to the authority having jurisdiction. Include copies of shop drawings as required to depict component locations to facilitate review. Upon receipt of comments from the Authority, make resubmissions if required to make clarifications or revisions to obtain approval.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: A factory authorized installer is to perform the work of this section.
- B. Each and all items of the Fire Alarm System shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by Underwriters Laboratories, Inc. (UL), and shall bear the "UL" label.

1.07 MAINTENANCE SERVICE

- A. Maintenance Service Contract: Provide maintenance of fire alarm systems and equipment for a period of 12 months, using factory-authorized service representatives.
- B. Basic Services: Systematic, routine maintenance visits on a quarterly basis at times scheduled with the Owner. In addition, respond to service calls within 24 hours of notification of system trouble. Adjust and replace defective parts and components with original manufacturer's replacement parts, components, and supplies.
- C. Additional Services: Perform services within the above 12-month period not classified as routine maintenance or as warranty work when authorized in writing. Compensation for additional services must be agreed upon in writing prior to performing services.
- D. Renewal of Maintenance Service Contract: No later than 60 days prior to the expiration of the maintenance services contract, deliver to the Owner a proposal to provide contract maintenance and repair services for an additional one-year term. Owner will be under no obligation to accept maintenance service contract renewal proposal.

PART 2 PRODUCTS

2.01 FIRE ALARM CONTROL PANEL (FACP)

- A. General: Comply with UL 864, "Control Units for Fire-Protective Signaling Systems."
- B. The following FACP hardware shall be provided:
 1. Non-Power Limited base panel with platinum cabinet and door, 120 VAC input power.
 2. 1000 Addressable point capacity (inputs or outputs).
 3. 2000 points of annunciation where one (1) point of annunciation equals:
 - a. LED or 1 switch on an LED/switch module.
 4. Two, four or six Notification Appliance Circuit Class B modules for system expansion.

5. Four CPU controlled Auxiliary Control Relays, DPDT contacts rated for 3A @ 24 VDC or 120 VAC, resistive.
 6. Provide battery voltage and ammeter readouts from the LCD Display.
 7. The FACP shall support up to five (5) RS-232-C ports.
 8. Common Event DACT.
- C. Cabinet: Lockable steel enclosure. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control unit, provide exactly matching modular unit enclosures.
- D. Alphanumeric Display and System Controls: Panel shall include an 80 character LCD display to indicate alarm, supervisory, and component status messages and shall include a keypad for use in entering and executing control commands.
- E. Voice Alarm: Provide an emergency communication system, integral with the FACP, including voice alarm system components, microphones, amplifiers, and tone generators. Features include:
1. Amplifiers comply with UL 1711, "Amplifiers for Fire Protective Signaling Systems."
 2. Single alarm channel(s) permit transmission of announcements to different zones or floors automatically or by use of the central control microphone. All announcements are made over dedicated, supervised communication lines.
- F. Status annunciator indicates the status of the various voice alarm speaker zones and the status of communication zones.
- G. Distributed Module Operation: FACP shall be capable of allowing remote location of the following modules; interface of such modules shall be through a Style 4 (Class B) supervised serial communications channel:
1. Amplifiers, voice and telephone control circuits
 2. Addressable Signaling Line Circuits
 3. Initiating Device Circuits
 4. Notification Appliance Circuits
 5. Auxiliary Control Circuits
 6. LED/Switch Control Modules

2.02 ADDRESSABLE MANUAL PULL STATIONS

- A. Description: Addressable Single-action type, red LEXAN or metal, and finished in red with molded, raised-letter operating instructions of contrasting color. Station will mechanically latch upon operation and remain so until manually reset by opening with a key common with the control units.

2.03 SMOKE DETECTORS

- A. General: Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems." Include the following features:
1. Factory Nameplate: Serial number and type identification.
 2. Operating Voltage: 24 VDC, nominal.
 3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore normal operation.
 4. Plug-In Arrangement: Detector and associated electronic components are mounted in a module that connects to a fixed base with a twist-locking plug connection. Base shall provide break-off plastic tab that can be removed to engage the head/base locking mechanism. No special tools shall be required to remove head once it has been locked. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control unit.
 5. Each detector head shall contain an LED that will flash each time it is scanned by the Control Unit (once every 4 seconds). In alarm condition, the detector head LED shall be on steady.

6. Each sensor shall be scanned by the Control Unit for its type identification to prevent inadvertent substitution of another sensor type. Upon detection of a "wrong device", the control unit shall operate with the installed device at the default alarm settings for that sensor; 2.5% obscuration for photoelectric sensor, 135-deg F and 15-deg F rate-of-rise for the heat sensor, but shall indicate a "Wrong Device" trouble condition.
 7. The sensor's electronics shall be immune from false alarms caused by EMI and RFI.
 8. Addressability: Sensors include a communication transmitter and receiver in the mounting base having a unique identification and capability for status reporting to the FACP. Sensor address shall be located in base to eliminate false addressing when replacing sensors.
 9. Removal of the sensor head for cleaning shall not require the setting of addresses.
- B. Type: Smoke detectors shall be of the photoelectric type. Where acceptable per manufacturer specifications.
- C. Duct Smoke Detector: Photoelectric type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied. Detector includes relay as required for fan shutdown.
1. The Duct Housing shall provide a supervised relay driver circuit for driving [up to 15 relays with a single "Form C" contact rated at 7A@ 28VDC or 10A@ 120VAC] [an auxiliary alarm relay with two "Form C" contacts rated at 1A@ 28VDC or ½A@ 120 VAC resistive. This auxiliary relay operates when the detector reaches its alarm threshold.
 2. Duct Housing shall provide a relay control trouble indicator Yellow LED.
 3. Compact Duct Housing shall have a transparent cover to monitor for the presence of smoke. Cover shall secure to housing by means of four (4) captive fastening screws.
 4. Duct Housing shall provide two (2) Test Ports for measuring airflow and for testing. These ports will allow aerosol injection in order to test the activation of the duct smoke detector.
 5. For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housing front cover.
 6. Each duct detector shall have a alarm LED.

2.04 ALARM-NOTIFICATION APPLIANCES

- A. Visible/Only: Strobe shall be listed to UL 1971. The V/O shall consist of a xenon flash tube and associated lens/reflector system. The V/O enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. V/O appliances shall be provided with different minimum flash intensities of 15cd, 75cd and 110cd. Provide a label inside the strobe lens to indicate the listed candela rating of the specific Visible/Only appliance.
- B. Speaker: Speaker notification appliances shall be listed to UL 1480.
1. The speaker shall operate on a standard 70.7VRMS NAC using twisted/shielded wire.
 2. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84dBA at 10 feet.
 3. The speaker shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for General Signaling.
 4. The speaker installs directly to a 4" square, 1 1/2 in. deep electrical box with 1 1/2" extension.]

2.05 ADDRESSABLE CIRCUIT INTERFACE MODULES

- A. Addressable Circuit Interface Modules: Arrange to monitor one or more system components that are not otherwise equipped for addressable communication. Modules shall be used for monitoring of waterflow, valve tamper, non-addressable devices, and for control of evacuation indicating appliances and AHU systems.
- B. Addressable Circuit Interface Modules will be capable of mounting in a standard electric outlet box. Modules will include cover plates to allow surface or flush mounting. Modules will receive their operating power from the signaling line or a separate two wire pair running from an appropriate power supply as required.

- C. The Circuit Interface Module shall be supervised and uniquely identified by the control unit. Module identification shall be transmitted to the control unit for processing according to the program instructions. Modules shall have an on-board LED to provide an indication that the module is powered and communicating with the FACP. The LEDs shall provide a troubleshooting aid since the LED blinks on poll whenever the peripheral is powered and communicating.

2.06 EMERGENCY POWER SUPPLY

- A. General: Components include battery, charger, and an automatic transfer switch.
- B. Battery: Sealed lead-acid or nickel cadmium type. Provide sufficient capacity to operate the complete alarm system in normal or supervisory (non-alarm) mode for a period of 24hours. Following this period of operation on battery power, the battery shall have sufficient capacity to operate all components of the system, including all alarm indicating devices in alarm or supervisory mode for a period of 5 minutes.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install system components and all associated devices in accordance with applicable NFPA Standards and manufacturer's recommendations.
- B. Installation personnel shall be supervised by persons who are qualified and experienced in the installation, inspection, and testing of fire alarm systems. Examples of qualified personnel shall include, but not be limited to, the following:
 - 1. Factory trained and certified personnel.
 - 2. National Institute of Certification in Engineering Technologies (NICET) fire alarm level II certified personnel.
 - 3. Personnel licensed or certified by state or local authority.

3.02 EQUIPMENT INSTALLATION

- A. Furnish and install a complete Fire Alarm System as described herein and as shown on the plans. Include sufficient control unit(s), annunciator(s), manual stations, automatic fire detectors, smoke detectors, audible and visible notification appliances, wiring, terminations, electrical boxes, and all other necessary material for a complete operating system.
- B. Water-Flow and Valve Supervisory Switches: Connect for each sprinkler valve required to be supervised.
- C. Device Location-Indicating Lights: Locate in the public space immediately adjacent to the device they monitor.

3.03 WIRING INSTALLATION

- A. System Wiring: Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the Authority Having Jurisdiction AHJ and shall be installed in accordance with the appropriate articles from the current approved edition of NFPA 70: National Electric Code (NEC).
- B. Contractor shall obtain from the Fire Alarm System Manufacturer written instruction regarding the appropriate wire/cable to be used for this installation. No deviation from the written instruction shall be made by the Contractor without the prior written approval of the Fire Alarm System Manufacturer.
- C. Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm initiating device circuits wiring and a different color code for supervisory circuits. Color-code notification appliance circuits differently from alarm-initiating circuits. Paint fire alarm system junction boxes and covers red.
- D. Wiring to Central Station Transmitter: 1-inch conduit between the FACP and the central station transmitter connection as indicated. Install number of conductors and electrical supervision for connecting wiring as required to suit central-station monitoring function. Final connections to terminals in central station transmitter are made under another contract.

3.04 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.
- B. Service personnel shall be qualified and experienced in the inspection, testing, and maintenance of fire alarm systems. Examples of qualified personnel shall be permitted to include, but shall not be limited to, individuals with the following qualifications:
 - 1. Factory trained and certified.
 - 2. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified.
 - 3. International Municipal Signal Association (IMSA) fire alarm certified.
 - 4. Certified by a state or local authority.
 - 5. Trained and qualified personnel employed by an organization listed by a national testing laboratory for the servicing of fire alarm systems.
- C. Pretesting: Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.
- D. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing.
- E. Minimum System Tests: Test the system according to the procedures outlined in NFPA 72.
- F. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.
- G. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log.
- H. Final Test, Certificate of Completion, and Certificate of Occupancy:
 - 1. Test the system as required by the Authority Having Jurisdiction in order to obtain a certificate of occupancy.

3.05 CLEANING AND ADJUSTING

- A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Clean unit internally using methods and materials recommended by manufacturer.
- B. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

3.06 TRAINING

- A. Provide the services of a factory-authorized service representative to demonstrate the system and train Owner's maintenance personnel as specified below.
 - 1. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of 8 hours' training.
 - 2. Schedule training with the Owner at least seven days in advance.

END OF SECTION

SECTION 17010
COMMUNICATIONS EQUIPMENT AND MATERIALS

PART 1 GENERAL

1.01 INSTRUCTION:

- A. The Communications Contractor(s) is to either copy or remove this specification section from the spec book and complete as follows:
 - 1. Indicate the specific manufacturer on which the bidder's base bid price is based in the blank space provided.
 - 2. All equipment is to be bid as specified. Material or equipment from another manufacturer may be bid as a Voluntary Alternate, but the dollar amount must be shown as an "Add" or "Deduct" to the base bid. Provide the name of the alternate manufacturer in the space provided.
 - 3. Insert the name(s) of each subcontractor used in your bid in the space provided in Part 3.
 - 4. This form shall be submitted with the bid.

1.02 RELATED DOCUMENTS:

- A. The other Contract Documents complement the requirements of this Section. The General Requirements apply to the work of this section.

PART 2 PRODUCTS

2.01 THE FOLLOWING IS A LIST OF APPROVED MANUFACTURERS, GROUPED ACCORDING TO TYPES OF MATERIALS OR EQUIPMENT.

- A. Server Racks:
 - 1. APC
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____
- B. CAT6 Cabling and Patch Cords:
 - 1. Commscope/Systimax, Belden/CDT and General Cable
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____
- C. CAT6 Faceplates and Patch Panels:
 - 1. Commscope/Systimax, Belden/CDT and Hubbell
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____
- D. J-hooks:
 - 1. Caddy Cat and Panduit J-Pro
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____
- E. Fiber Optic Cable:
 - 1. OM3, Siecor, Commscope/Systimax, and Belden/CDT
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____
- F. Fiber Optic Cable Innerduct:
 - 1. Amco, Carlon, Panduit and Endocor
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____
- G. Fiber Optic Connectors
 - 1. Commscope/Systimax and Belden/CDT
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____

- H. Data Rack Uninterruptable Power Supply (UPS)
 - 1. APC
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____
- I. Power-over-Ethernet (PoE) Clocks
 - 1. Dukane, Simplex, American Time & Signal
 - a. Voluntary alternate _____
 - b. Add \$ _____ Deduct \$ _____

PART 3 SUBCONTRACTORS

3.01 INSERT THE NAME OF EACH SUBCONTRACTOR AND WORK TO BE PERFORMED BELOW:

- A. Subcontractor _____
Work Performed _____
- B. Subcontractor _____
Work Performed _____
- C. Subcontractor _____
Work Performed _____

END OF SECTION

SECTION 17100
TELEPHONE AND DATA CABLING SYSTEM

SECTION 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. The intent is to provide a complete telephone and data structured cable system. The specification includes horizontal and riser wiring for telephone system and data network. The work shall include but not limited to all cables, conduits, raceways, cable support systems, workstation outlets, main distribution racks hardware and grounding.
- B. Contractor is responsible for installation in accordance with applicable Local, State, and Federal guidelines. All cabling shall be in accordance with ANSI/TIA/EIA-568-C standard.
- C. Proposal shall be an end-to-end solution incorporating all cabling, connectors, cross connections, and termination receptacles required from the mechanical room punch panel to the workstation.
- D. Scope of work is shown on Electrical Systems Plans (Drawing Sheets E1S, E2S, E3S, and E4S) for data drop locations and rough-in details.

1.02 SUBMITTALS

- A. Shop Drawings
 - 1. Composite wiring and/or schematic diagrams of complete cabling system as proposed to be installed.
- B. Product Data
 - 1. Catalog sheets, Specifications and Installation Instructions
 - 2. Bill of materials.
- C. Contract Closeout Submittals
 - 1. Cabling System acceptance test report.
 - 2. Certificate: Affidavit, signed by the Company Field Advisor and notarized, certifying that the cabling system meets the contract requirements and is operating properly.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Basic Materials and Methods

1.04 CABLE DELIVERY

- A. No cable over one (1) year old when delivered to the site will be accepted.

1.05 CABLING SYSTEM ACCEPTANCE

- A. Inspection of the installed cable system shall be made by the Owner and Engineer to verify that the installation conforms to all the requirements stated herein, and that the cabling system is 100% defects free. The acceptance criteria shall include, but not be limited to:
- B. Completed installation and functional operation of wire, cable, and raceway.

SECTION 2 - PRODUCTS

2.01 MAIN DISTRIBUTION FRAME (MDF) & INTERMEDIATE DISTRIBUTION FRAME (IDF)

2.02 FLOOR STANDING EQUIPMENT RACKS AND CABINETS

- A. Description
 - 1. Place where shown on contract drawings.
 - a. Server Room 127: Two (2) floor standing racks required.
 - 2. 4 post open frame with square holes.
 - 3. Finish: Powder Black.
 - 4. Provide all hardware for floor mounting and anchoring.
 - 5. Provide ground bar kit and hardware for each rack and bond rack to building TEG (telephone equipment ground) with No. 6 AWG ground wire.
 - 6. Connect ganged cabinets together.

7. Secure rack to nearest wall with ladder or basket tray for proper cable routing.
8. Include UPS in each rack rated for 3000VA each. Each UPS requires NEMA L5-30R outlet.

B. Manufactures

1. Rack - APC NetShelter #AR203A
2. UPS - APC Smart-UPS #SMT3000RM2U

2.03 WALL MOUNTED EQUIPMENT RACKS/ENCLOSURES

A. Description

1. Place where shown on contract drawings.
 - a. I.T. Closet 155: One (1) wall mounted rack required.
 - b. Mechanical/Electrical 225: One (1) wall mounted rack required.
2. Mount securely to plywood backboard.
3. Finish: Powder black.
4. Rated - 12U Minimum
5. The rack shall have a center swing-out enclosure with a minimum depth of 22".
6. All racks shall be keyed alike.
7. Bond rack backpan to building TEG (telephone equipment ground) with No. 6 AWG ground wire.
8. Include UPS in each enclosure rated for 1500VA each. Each UPS requires NEMA 5-20R outlet.

B. Manufactures

1. Rack - APC
2. UPS - APC Smart-UPS #SMT1500RM2U

2.04 WIRING

A. Data Network

1. Provide primary bid price using UTP network cabling meeting Category 6 specifications.
2. All data network UTP CAT6 cabling to be blue with blue keystone jacks.
3. UTP network cabling in Server Room (MDF) 127, I.T. Closet (IDF-1) 155, Mechanical/Electrical Room (IDF-2) 225, wall mounted 110 modular patch panel(s) to office/classroom wall/ceiling mount keystone 8P8C modular (RJ45) connector receptacles. (See Data/ port schedule and prints).

B. Audio/Video STP cabling (point to point)

1. Provide primary bid price using shielded cabling (CAT6-STP) and connectors meeting Category 6 specifications.
2. A/V STP Cabling to be yellow.

2.05 RACEWAY, CABLE TRAY AND CABLE SUPPORT

- A. Refer to Specification and Engineered Drawings, Basic Materials and Methods, for the routing of the telephone and data cable.
- B. Do not fill communications raceway beyond 40% capacity for conduit and sleeves
- C. Bond cable tray to building TEG (telephone equipment ground) with No. 6 AWG green ground wire and connect section through approved connectors to assure continuous bond for the entire installation.
- D. Support cable every 4 feet vertically with "D" rings screwed to edges of backboard
- E. Support cable every 4 feet horizontally with "J" hooks. Approved manufacturers: Caddy CAT series and Panduit J-Pro.
- F. Observe manufacturer recommended load ratio and do not over fill support to minimize pressure on cables.

- G. All floor penetrations shall be core drilled with a maximum ¼' size greater than the exterior dimension of the riser conduit, and sleeve.
- H. All floor penetrations through precast concrete shall be approved by Architect/Engineer.
- I. Sleeves shall be installed by the electrical contractor and must include nylon bushings for cable protection.
- J. Do not exceed manufacturers minimum bend radius
- K. Do not tie-wrap cable. Provide UL approved Velcro cable ties and leave cable loose in ties

2.06 FIRE STOPPING

- A. Comply with Chapter 7 of the Telecommunications Distribution Methods manual 11th edition
- B. Comply with EIA/TIA-569-A, Annex A "Firestopping"
- C. Install firestopping label in to each side of penetrated fire barrier within 12 inches of firestopping material. Labeling shall comply with TIA/EIA-606 latest revision.

2.07 LABELS

- A. Labels
 - 1. Provide typewritten labels on all cables at each termination point detailing each type service, room, receptacle, and port numbers. Identification shall be by means of wrap around "brady" type labels or similar machine labeled type that is preapproved by the Owner. All workstation outlets must be labeled and all circuits clearly identified utilizing designation strips in compliance with TIA/EIA 606 standards.

2.08 TERMINATIONS

- A. Cable Runs shall terminate as follows:
 - 1. Each station shall have the quantity of cables as indicated on the drawings terminated on al faceplate with modular outlets configured as per TIA/EIA jack designation T568B terminating the Category 6 cable. Connecting hardware shall be marked and comply with TIA/EIA performance levels associated with the particular cable being terminated.
 - 2. Network drops for ceiling mounted cameras and wireless access points to be terminated above ceiling with 8P8C modular (RJ45) connectors and 4ft service loop.

SECTION 3 - EXECUTION

3.01 INSTALLATION

- A. Cabling in office areas, classrooms/labs and hallway will be above dropped ceiling and will be supported by an appropriate cable management system (i.e. "J" hook, cable tray, etc.)
- B. Rough-ins (i.e. boxes with conduit stubbed into the accessible ceiling areas above rooms) will be provided by the project Electrical Subcontractor, cabling contractor shall coordinate any special requirements with the Electrical Subcontractor prior to rough-in.
 - 1. Wall boxes - Power, A/V and Network Data cabling to terminate in Legrand Evolution Series #EFSB4 (4 gang) wall boxes with: 1 duplex power, 1 gang,
 - a. Gang 1 - duplex power
 - b. Gang 2 - 4 banana plug (for speakers)
 - c. Gang 3 - 2 data and 4 A/V CAT6 keystone jacks as required (6 total jacks)
 - d. Gang 4 - 6 A/V CAT6 keystone jacks as required (6 total jacks)
- C. Audio/Video Cabling to wall mounted projectors or TVs (classroom, labs, meeting rooms), may be surface mounted from ceiling to wall boxes with wiremold 5400 and quad boxes (one duplex power, one duplex with 4-CAT6 keystones) bottom of the outlet box 96" from floor.
- D. All classroom/lab/meeting room/community room overhead projectors, short throw projectors, and TV locations have 2 CAT6 STP Point to Point and 1 network data port. Note: All of these are used for presentation from a computer.
- E. TVs in the Lobby 101, Concourse 116, and Fitness 130 have single network data ports.

- F. NOTE: TVs in conference rooms 114, 148, and 158 are connected to a computer via HDMI and do not need infrastructure cabling.

3.02 GROUNDING

- A. The MDF shall be properly grounded in accordance with ANSI/TIA/EIA-607 and NEC, including Article 800. Contractor shall provide a #6 AWG copper conductor in ¾" conduit from the Ground bar mounted on the MDF to the "Grounding Busbar" of the main water pipe and continue this ground to each installed IDF.

3.03 TESTING

- A. Cabling System Acceptance Test
1. All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA/EIA-568-C; marginal passes (*PASS) are not acceptable. All pairs of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.
 2. All twisted-pair links shall be tested for continuity, pair reversals, shorts, opens and performance as indicated below.
 3. Horizontal cabling shall be tested using a Level III test unit for category 6 performance compliance. The basic tests required are:
 - a. Wire Map
 - b. Length
 - c. Attenuation
 - d. NEXT (Near end crosstalk)
 - e. Return Loss
 - f. ELFEXT Loss
 - g. Propagation Delay
 - h. Delay skew
 - i. PSNEXT (Power sum near-end crosstalk loss)
 - j. PSELFEXT (Power sum equal level far-end crosstalk loss)
- B. All UTP test results will be delivered to the Owner.

3.04 TRAINING & WARRANTY

- A. Contractor shall conduct 1 - 1 hr. training session on the operation & control of the Telephone, Television and Data Cabling Systems. Notify owner 72 hours prior to coordinating a meeting session.
- B. Proposal shall include a minimum 15-year performance warranty on all fiber and UTP cabling.

END OF SECTION

**SECTION 17200
FIBER OPTIC CABLING SYSTEM**

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. The intent of this specification is to provide fiber optic backbone of the Local Area Network. The configuration is as shown on the drawings and described herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Telephone and Data Cabling System Section 17100.

1.03 SUBMITTALS

- A. Submit the shop drawings, product data, samples and quality control specified below at the same time as a package.
- B. Shop Drawings:
 - 1. Complete manufacturers' construction details and specifications for the cables, including physical characteristics of optical fiber, strength members and jackets.
 - 2. Overall dimension of cable.
 - 3. Termination data, including the following:
 - a. List of materials
 - b. Method of terminating cables
 - c. Precautionary measures
 - d. Written statement from cable manufacturer that terminations submitted are acceptable, and suitable for the proposed application.
 - 4. Cable manufacturer's certified test data (attenuation, bandwidth).
 - 5. Maximum pulling strain allowed for each type cable.
- C. Product Data:
 - 1. Catalog sheets, specifications and installation instructions for all products.
 - 2. Written statement from cable manufacturer indicating recommended pulling compounds.
- D. Samples:
 - 1. Two (2) foot samples of each type cable if requested.
 - 2. Samples of termination materials if requested.
- E. Quality Control Submittals:
 - 1. Installers' Qualifications Data: Include the following who will be performing the work:
 - a. Employers name, business address and telephone number
 - b. Name and addresses of the required number of similar projects worked on which meet the experience criteria.
- F. Contract Closeout Submittals:
 - 1. After installation test reports

1.04 QUALITY ASSURANCE

- A. Installers' Qualifications:
 - 1. The persons installing the work of this section shall be personally experienced in optical fiber cabling system and shall have been engaged in the installation of optical fiber cable for a minimum of two (2) years.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Cable Delivery:
 - 1. No cable over one (1) year old when delivered to the site will be accepted.
 - 2. Keep ends of cables sealed at all times, except when making terminations. Use methods approved by cable manufacturer.

- B. Cable Storage:
 - 1. Store where cable will be at temperature recommended by cable manufacturer for optimum workability.

PART 2 - PRODUCTS

2.01 FIBER CABLE

- A. Contractor and/or Equipment Supplier may propose alternate equipment or materials of EQUAL or better quality, function, performance, durability and appearance. This information is to be submitted to the Engineer's Office ten (10) working days prior to bid due date to allow for proper review time and to issue an addendum incorporating the acceptable substitution(s). It is the submitter's responsibility to provide sufficient material for review as required by Engineer's Office. Acceptance and approval is the responsibility of the Owner.

2.02 CABLE

- A. Fiber runs from Server Room 127 to I.T. Closet 155 and Mechanical/Electrical Room 225 to be 50 / 125um OM3 6 strand multimode distribution cable with LC connector terminations.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Installing Cables:
 - 1. Install cables in conduit or innerduct unless Interlocking Armored is used
 - 2. Keep ends of cables sealed watertight at all times, except when making splices or terminations.
 - 3. No grease, oil, lubricant other than approved pulling compound may be used to facilitate the pulling-in of cables.
 - 4. Use pulling attachment connected to the cable strength member for pulling in cables. Seal pulling attachment watertight.
- B. Terminations:
 - 1. The fiber to be terminated shall be precision cleaved and prepped before splicing and shall be protected by a heat shrink insulated tube. Terminate cable in accordance with manufacturer's approved installation instructions.
- C. Identification of Fiber Cables: Identify cables in MDF and IDF patch panels:
 - 1. Install tags on each cable indicating cable number, date installed (month, year), type of cable and manufacturer. Attach tags to cables with nonferrous metal wire or brass chain.
 - 2. Use markers to identify each optical fiber in equipment to which they connect.

3.02 FIELD QUALITY CONTROL

- A. Testing:
 - 1. All Multimode fibers shall be tested to the requirements of ANSI/EIA/TIA-568-B, TIA-525-14A (Method A.1) and TSB-140. Optical fibers shall be tested at both 850 nm and 1300 nm wavelengths for end-to-end insertion loss and Bi -Directional (MTR to TR-1, TR-1 to MTR)
 - 2. Submit printed report of test results signed by Company Field Advisor and Owner's Representative.

3.03 TRAINING & WARRANTY

- A. Contractor shall conduct 1 - 1 hr. training sessions on the operation & control of the Fiber Optic Cabling System. Notify owner 72 hours prior to coordinating a meeting session.
- B. Proposal shall include a minimum 15-year performance warranty on all fiber and UTP cabling.

END OF SECTION

SECTION 17300
MASTER TIME & CONTROL SYSTEM

PART 1 GENERAL

1.01 SCOPE

- A. The work covered by this section of the specifications includes the furnishing of all labor, equipment, materials, and performing all operations in connection with the installation of the Synchronized Master Power of Ethernet (PoE) Time and Control System as shown on the drawings, as hereinafter specified, and as directed by the architect/engineer.
- B. Contractor to setup IP addresses and provide connections to a time server via Simple Network Time Protocol.

1.02 RELATED DOCUMENTS

- A. General conditions of the Division 1 - General Requirements shall apply to the work specified in this section.
- B. Section 16000 - General Provision for Electrical work and Section - Basic Materials and Methods shall apply to the work specified in this Section.

1.03 DESCRIPTION

- A. System Description
 - 1. System shall be a Power-over-Ethernet controlled master time system, UL listed, fully installed, programmed, tested and left in first class operating condition.

1.04 QUALITY ASSURANCE

- A. Requirements of regulatory agencies:
 - 1. National Electrical Code (NEC)
 - 2. Underwriters' Laboratories, Inc. (UL)
- B. Equipment shall be the product offering of a firm who has been actively manufacturing master time and control systems for a minimum of ten (10) years.
- C. The equipment shall be provided by a company with an ISO9001 approved quality system and procedures.
- D. Manufacturer's services:
 - 1. At the time of final checkout, technician shall give operational instructions to the owner and/or his representative on the system.

1.05 SUBMITTALS

- A. Submit in accordance with Section 16000.
 - 1. Product data sheets and equipment description.
 - 2. Bill of materials listing all components and devices.
 - 3. Component wiring diagrams.
 - 4. System wiring and interconnection diagrams.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Receive equipment at job site; verify applicable components and quantity delivered.
- B. Handle equipment to prevent internal components' damage and breakage, as well as denting and scoring of enclosure finish.
- C. Equipment found to be damaged shall not be installed.
- D. Store equipment in a clean, dry space and protect from dirt, fumes, water, construction debris and physical damage.
- E. After installation, protect equipment from damage by work of other trades.
- F. Provide operating instructions and maintenance manuals detailing component and general system operating description.

1.07 GUARANTEE

- A. The electrical contractor shall guarantee all wiring and terminal equipment to be free from inherent and mechanical defects due to workmanship and materials used for a period of one (1) year from date of accepted installation.
- B. It shall be the responsibility of the master time and control system equipment manufacturer, and not distributor or electrical contractor, to furnish a one (1) year written warranty. Warranty shall list all equipment in the system and state that equipment to be free from inherent and mechanical defects due to workmanship and materials for a period of one (1) year from date of startup or beneficial use of the system.
- C. Warranty service for the equipment shall be provided by the system manufacturer's factory trained representative during normal working hours, Monday through Friday, excluding holidays. Emergency service provided at times other than as stipulated above shall be available from the same source at additional cost to the owner.
- D. For follow-up visits or service calls, the provider must be able to respond from a local site that is located less than 50 miles from the actual jobsite.

PART 2 PRODUCTS

2.01 GENERAL

- A. The work covered by this section includes the system equipment specified and installation.
- B. Refer to Section 17100 for necessary PoE network cabling details.
- C. Basis of design are based on Edwards Dukane 24IP Series PoE Clocks.

2.02 SYSTEM OPERATION

- A. Site with PoE-enabled network equipment
 - 1. Time is automatically set by a timer server via Simple Network Time Protocol (SNTP). No master clock or serial connection is required.
 - 2. PoE Clocks automatically request and receive power from a PoE-enabled switch that conforms to the IEEE 802.3af standard.
 - 3. Power to multiple clocks with a single switch or PoE injector, verify that the device can deliver 15.4 W per port as specified by IEEE 802.3af.
 - 4. See the Specifications table for power consumption requirements for each PoE clock. Refer to manual supplied with PoE-enabled power sourcing equipment for the specific output rating.
- B. Includes the following basic settings:
 - 1. Local time server
 - 2. IP address
 - 3. Local time zone
 - 4. Daylight Saving Time

2.03 INDICATING CLOCKS

- A. Analog Clocks
 - 1. Visible from a minimum 100 feet.
 - 2. Single sided, 12" diameter clock with black housing finish.
 - 3. 12 hour format
 - 4. Three year warranty
- B. Digital clocks
 - 1. Visible from a minimum of 150 feet.
 - 2. Single sided, 4-digit clock with stainless steel case
 - 3. Red 7-segment LED display
 - 4. 12/24 hour format
 - 5. Three year warranty

- C. All clocks shall be equipped to operate with and be synchronized by the herein specified central time system.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which master time and program system is to be installed and notify engineer in writing of conditions detrimental to proper and timely completion of work.
- B. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Requirements:
 - 1. Install conduit as specified in Section 16050 and as shown on drawings.
 - 2. Install and label wiring as specified in Section 17100.
 - 3. All cabling shall be color coded to facilitate installation and service & shall be installed in conduit sleeves with bushings, cable tray, or supported as required.
 - 4. Each clock requires a unique IP address in order to access the network. IP addresses can be dynamic or static. Use either of the following protocols:
 - a. Dynamic Host Configuration Protocol (DHCP)
 - b. Terminal Network Protocol (telnet)

3.03 ADJUSTMENT AND CLEANING

- A. Clean system equipment and enclosures of dirt and debris at time of installation.
- B. Testing - The completed Master Time System shall be fully tested by the contractor in the presence of the owner's representative. Upon completion of a successful test, the contractor shall so certify in writing to the owner, architect, and general contractor.
- C. Training - The equipment manufacturer's representative shall provide, as part of this contract, a minimum of 2 hours training for the building owner. This training shall be conducted by factory trained personnel.

END OF SECTION

