TO: All Bidders

FROM: City of Cambridge

DATE: January 31, 2022

RE: File No. 10133 – Renovations to the Simard and Frazier Buildings - Addendum No. 1

Notice of Omissions: Sections 260000, 270000 and 280000 were inadvertently omitted. They are attached to this addendum.

All other details remain the same.

Elizabeth Unger
Purchasing Agent

Addendum No. 1
SECTION 260010

ELECTRICAL
(Filed Sub-Bid Required)

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PART 1 - GENERAL

1.1 FILING OF FILED SUB-BIDS

A. The work of this section shall be included in the Electrical Filed Sub-Bid. Refer to Section 26 00 01: ELECTRICAL FILED SUB BID SUMMARY for additional requirements.

1.2 REQUIREMENTS FOR FILING SUB-BIDS

A. Time, Manner and Requirements for Submitting Sub-Bids:

1. Sub-bids for work under this Section shall be for the complete work and shall be filed in a sealed envelope with the Public Agency at a time and place as stipulated in the “Instructions to Bidders.”

2. Each sub-bid submitted for work under this Section shall be on forms furnished by the Awarding Authority as required by Section 44F of Chapter 149 of the General Laws, as amended.

3. Sub-bids filed with the Awarding Authority shall be accompanied by Bid Bond, Cash, Certified Check, Treasurer’s Check, or Cashier’s Check issued by a responsible bank or trust company payable to the Town of Ashland in the amount of 5 percent of the sub-bid. A sub-bid accompanied by any other form of bid deposit than those specified will be rejected.

B. Sub Sub-Bid Requirements:

Class of Work    Section Number
Communications    27 00 00
Integrated Electronic Security System 28 00 00

If Sub-Bidder intends to perform with persons of his own staff the classes of work listed above, he must nevertheless list his own name therefore, under Paragraph E, of the FORM FOR SUB-BID.

C. The Work of this Section is shown on the following Drawings: TBD.

The Sub-Bid Contractor shall also examine all other Drawings and all other Sections of the Specifications for requirements therein affecting the Work of this Section, not just those pertaining to this Sub-trade.

1.3 ALTERNATES

A. Refer to Section 01 23 00 for Alternates affecting this section.
1.4 RELATED DOCUMENTS

A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Related Documents identified in Division 01 Section “Summary.”

1.5 GENERAL REQUIREMENTS

A. The Conditions of the Contract and General Requirements of the Project Manual apply to this Subcontractor, material suppliers, and all other persons furnishing labor and materials under this Section. The General Conditions, and applicable parts of Division 01 are included as part of this Section.

B. Examine all Project Specifications and Drawings for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.

C. Coordinate work with that of all other trades affecting or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

D. The following definitions apply to the Drawings and Specifications:

1. Furnish: The term "furnish" is used to mean "supply and deliver to the Project Site, ready for unloading, unpacking, assembly, installation, and similar operations".

2. Install: The term "install" is used to describe operations at the Project Site including actual "unloading, unpacking, assembly, erection, piecing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations".

3. Provide: The term "provide" is used to mean "furnish and install, complete and ready for the intended use".

4. Installer: An "installer" is the Contractor or an entity engaged by the Contractor, either as an employee, Subcontractor, or Sub-Subcontractor for performance of a particular construction activity, including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform.

E. When open-flame or spark producing tools such as blow torches, welding equipment, and the like are required in the process of executing the work, the General Contractor shall be notified not less than twenty four (24) hours in advance of the time that the work is to begin and the location where work is to be performed. Provide fire protective covering and maintain constant non-working fire watch where work is being performed until it is completed.

1.6 DESCRIPTION OF WORK

A. Work described herein shall be interpreted as work to be done by the Electrical Sub-Contractor. Work to be performed by other trades will be referenced to a particular contractor.

B. Provide all labor, materials, tools, and equipment, including scaffolding, to complete the installation of the electrical system. Install, equip, adjust, and put into operation the respective portions of the installation specified, and so interconnect various items or sections of work in order to form a complete and operating whole. Systems may be referenced in singular or plural terms, also refer to drawings to confirm quantities.

C. The work shall consist of, but shall not necessarily be limited to the following:

1. Primary, secondary and low tension ductbanks, manholes, and handholes.
2. Secondary distribution equipment, including distribution panels, metering, motor controls, variable frequency drives, panelboards, including feeders and subfeeders.
3. Fire alarm system, addressable type.
4. Emergency power system, including battery units, emergency lighting and exit signs.
5. Lighting systems exterior and interior fixtures, and a complete automated addressable lighting control system with all sensors occupancy, daylight, photosensors, switches and Bacnet BMS integration.
6. All raceway systems, including boxes, couplings, and fittings.
7. All branch circuit wiring systems, including wiring devices and plates.
8. Excavation and backfill within building foundation walls for any underground raceways.
9. Connections for all building equipment, including mechanical, plumbing, fire protection, elevator, Owner furnished equipment, and the like.
10. Drilling, coring, and cutting of holes for electrical conduit systems, and equipment. Where the electrical contractor requires the G.C. to provide cutting and patching the E.C. shall reimburse the G.C. for the work done. Any cutting caused by the E.C. that causes delay due to poor coordination of the sequencing of work shall be reimbursed by the contractor performing the work.
12. Scaffolding, Rigging, and Staging required for all Electrical Work under (8) Eight ft. in height. Refer to Section 01 50 00 – Temporary Facilities and Controls.
13. Firestopping for all Electrical Systems. Refer to Section 07 84 00 – Firestopping.
14. Provide Seismic Restraints for all Electrical Systems conforming to the requirements of Section 23 05 48 which Section is herein incorporated by reference.
15. Coordination Drawings and BIM coordination.
16. Communications system provisions including 120 volt power sources, cable tray, j-hooks, raceways and backboxes for Communications Systems as shown on drawings and specified in Section 27 00 00, Communications.
17. Integrated Electronic Security System provisions, IESS including 120 volt power sources, cable tray, j-hooks, raceways, and backboxes for security systems as shown on drawings and specified in Section 28 00 00 – Integrated Electronic Security System.
18. Demolition of existing site electrics.
19. Sealing of all penetrations through walls, slabs, partitions, that are not fire rated.
20. Emergency Responder radio signal amplification system provisions as shown on drawings.
21. Two-way Communications call boxes system.
22. Provisions for Photovoltaic System as indicated on plans.
23. Temporary light and power, refer to Section 01 50 00 – Temporary Facilities and Controls.
24. Automated Lighting Control System, including start-up, programming, and coordination with Owner for the schedules.
25. Access Doors and frames - Refer to Section 08 31 13.
26. All testing of equipment installed.
27. Alternates affecting this section
28. Any other item of work hereinafter specified or indicated on electrical drawings.

1.7 DEFINITIONS

A. Most terms used within the documents are industry standard. Certain words or phrases shall be understood to have specific meanings as follows:

1. Reviewed: When used to convey Designer’s action on General Contractor’s submittals, applications and requests, “reviewed” is limited to Designer’s duties and responsibilities as stated in the Conditions of the Contract.
2. Directed: A command or instruction by Designer. Other Terms including “requested”, “authorized”, “selected”, “approved”, “required” and “permitted” have the same meaning as “directed”.

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3. Indicated: Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including “shown”, “noted”, “scheduled” and “specified” have the same meaning as “indicated”.

4. Regulations: Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions and agreements within the construction industry that control performance of the Work.

5. Furnish: Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation and similar operations.

6. Install: Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations.

7. Conduit: Raceways of the metallic type which are not flexible. Specific types as specified.

8. Connect: To wire up, including all branch circuitry, control and disconnection devices so item is complete and ready for operation.

9. Subject to Mechanical Damage: Equipment and raceways installed exposed and less than eight feet above finished floor in mechanical rooms or other areas where heavy equipment may be in use or moved.

10. Provide: Furnish and install completely connected up and in operable condition.

B. General: Basic Contract definitions are included in the Conditions of the Contract including, but not limited to, the following:

1. The Designer (the Architect-of-Record or Engineer-of-Record as applicable.)
2. The Owner’s Project Manager.
3. The General Contractor.

1.8 ITEMS TO BE FURNISHED ONLY

A. Furnish the following items for installation under designated sections.

1. Duct smoke detectors and duct carbon monoxide detectors with sampling tube, Section 230000 – HVAC.
2. Manholes and handholes – installed by Site Contractor.
3. Access Doors and Frames - Section 08 31 00.

1.9 ITEMS TO BE WIRED ONLY

A. Install the following items furnished under designated sections.

1. Specialty Backboxes for Communications, Security, and Audio/Visual, i.e; Speakers.: Division 27 and Division 28.

1.10 RELATED WORK

A. The following related work is to be performed under designated sections.

1. Temp. Controls – SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS.
2. Excavation and Backfill: DIVISION 31 – EARTHWORK (except within building foundation).
3. Concrete pads, and Duct Envelopes: DIVISION 03 - CONCRETE.
4. Insulation - SECTION 07 21 00 – THERMAL INSULATION.
5. Finish Painting: SECTION 09 91 13 – EXTERIOR PAINTING; SECTION 09 91 23 – INTERIOR PAINTING.
6. Payment for energy for temporary light and power shall be made by General Contractor. Refer to SECTION 01 50 00, TEMPORARY FACILITIES AND CONTROLS.

7. Automatic Temperature Control: SECTION 230000 - HEATING, VENTILATING & AIR CONDITIONING.

8. Hardware: SECTION 08 71 00 – DOOR HARDWARE

9. Communications System Equipment and Wiring: SECTION 27 00 00 – COMMUNICATIONS.

10. Integrated Electronic Security System, IESS Equipment and Wiring – Section 28 00 00 – INTEGRATED ELECTRONIC SECURITY SYSTEM.

11. Temporary Light and Power – Section 01 51 00 - TEMPORARY UTILITIES.

12. Fire stopping: Section 07 84 00 – FIRESTOPPING.

13. Scaffolding, Rigging, and Staging required for all Electrical Work over (8) Eight ft. in height. Refer to section 01 50 00 – TEMPORARY FACILITIES AND CONTROLS.


1.11 CONTRACT COST BREAKDOWN

A. Submit a breakdown of contract price to aid Architect in determining value of work installed as job progresses.

1.12 INSPECTION OF SITE

A. Electrical bidders will be permitted to inspect site. Failure to inspect existing conditions or to fully understand work which is required shall not excuse Electrical Subcontractor from his obligations to supply and install work in accordance with specifications and the drawings and under all site conditions as they exist.

1.13 CONTRACTOR'S REPRESENTATIVE

A. Retain a competent representative on the project.

1.14 COOPERATION

A. Work shall be carried on under usual construction conditions, in conjunction with other contractors work. Cooperate with other contractors, coordinate work and proceed in a manner as not to delay progress.

B. Before proceeding, examine all construction drawings and consult other contractors to coordinate installation and avoid interference.

C. In case of dispute, the Architect will render a decision in accordance with General and Supplementary General Conditions.

1.15 CODES, ORDINANCES, AND PERMITS

A. Codes and Ordinances:

All material and work provided shall be in accordance with all applicable codes including the following codes and standards as most recently amended.

State Building Code

Massachusetts Electric Code, 2020 Edition
State Department of Public Safety

NFPA 101 Life Safety Code

NFPA Standards

NEMA TCB 2-2017

Standards of the Underwriters Laboratories (UL)

Occupational Safety and Health Act (OSHA)

Americans with Disabilities Act (ADA)

Energy Conservation Code

City of Cambridge

B. Where contract documents indicate more stringent requirements than codes, the contract documents shall take precedence.

C. Permits: Be responsible for filing documents, and securing of inspection and approvals. Pay all permit fees.

D. Refer to INSTRUCTIONS TO BIDDERS. Contractor shall carry $150,000 for utility company back charge related to the permanent electric service.

1.16 ELECTRICAL ROOMS OR SPACES

A. Be responsible for ensuring that the dedicated space and clearances required in the NEC, Sections 110-26 are maintained for all electrical equipment.

B. Call other contractors' attention to the requirements contained in the above mentioned code sections, prior to the installation of equipment by other contractors, in order to ensure no violations.

1.17 SUBMITTALS

A. Refer to Supplementary General Conditions for information relative to submission of shop drawings. Submittals shall be electronic in PDF format. No equipment shall be installed prior to approval.

B. Notwithstanding any restrictions upon contractor proposed substitutions, should apparatus or materials be permitted by Architect to be substituted for those specified for good cause, and such substitution necessitates changes in or additional connections, piping, supports, or construction, same shall be provided. Assume cost and entire responsibility thereof.

C. Submit the following samples:

1. Lighting fixtures as may be requested.
2. Other items as may be requested.

D. Refer to Section 01 30 00 – Submittal procedures, for requirements.
1.18 GUARANTEE

A. All parts of the work shall be guaranteed for a period of one year from the date of acceptance of the job by Owner. If during that period of general guaranty, any part of the work fails, becomes unsatisfactory, or does not function properly due to any fault in material or workmanship whether or not manufactured or job built, the Owner shall upon notice from owner promptly proceed to repair or replace such faulty material or workmanship without expense to owner, including cutting, patching, and painting, or other work involved, and including repair or restoration of any damaged sections of the premises resulting from such faults.

B. In the event that a repetition of any one defect occurs indicating the probability of further failure and which can be traced to faulty design, material, or workmanship, then repair or replacement shall not continue to be made but the fault shall be remedied by a complete replacement of the entire defective unit.

C. In addition to the general guaranty, obtain and transmit to owner any guaranties or warranties from manufacturers of specialties, but only as supplementary to the general guaranty which will not be invalidated by same.

1.19 ELECTRICAL CHARACTERISTICS

A. In general, and unless specifically indicated otherwise, all building service, heating, ventilating, air conditioning, and plumbing equipment shall be of the following characteristics:

1. Motors up to and including 1/3 HP shall be suitable for 120 volts, one phase operation.
2. Motors larger than 1/3 HP shall be suitable for 208 volts, three-phase operation.
3. Electric heating equipment 1.5 KW and less shall be suitable for 120 volt single-phase operation. Over 1.5 KW shall be 208 volt, three phase.

B. Power Factor: All equipment provided rated greater than 1,000 watts and lighting equipment greater than 15 watts with an inductive reactance load component shall have a power factor of not less than 90 percent under rated load conditions.

1.20 TEMPORARY ELECTRICAL SUPPORT FACILITIES

A. Refer to Section 01 30 00 – ADMINISTRATIVE REQUIREMENTS.

B. Refer to Section 01 50 00 - TEMPORARY FACILITIES AND CONTROLS.

C. Provide own field office and/or storage facilities which shall be located as directed by the Architect. Provide all tools, equipment, ladders, and temporary construction required for execution of the work.

D. All scaffolding, ladders, and other temporary construction shall be rigidly built in accordance with all local and state requirements, and shall be removed upon completion.

1.21 INSPECTIONS AND TESTS

A. Inspection: If inspection of materials installed shows defects, such defective work, materials, and/or equipment shall be replaced and inspection and tests repeated.

B. Tests: Make reasonable tests and prove integrity of work and leave electrical installation in correct adjustment and ready to operate. All panels shall have phases balanced as near as practical. A consistent phase orientation shall be adhered to at all terminations.
1.22 ENERGY REBATE PROGRAM

A. This project has been designed to incorporate equipment approved for energy rebate such as fixtures, performance lighting, building lighting controls, and VFDs. Meet with Utility Company prior to lighting shop drawing submittal to ascertain that submittal meets program guidelines. Fixtures shall be DLC listed or equivalent. Assist Owner and Engineer in effort to obtain utility rebates the Owner is eligible for. Equivalent lighting fixtures which meet DLC shall require lighting vendor to submit shop drawings to utility company for approval. It is the intent of this project to Qualify for incentives which requires an additional 30 days of reported kWh saved and six months of lighting energy use data as reported by the system post-installation.

1.23 RECORD DRAWINGS

A. Refer to Section 01 70 00 – EXECUTION AND CLOSEOUT REQUIREMENTS for additional requirements. Provide two sets of black or blue line on white drawings to maintain and submit record drawings, one set shall be maintained at site and which shall be accurate, clear, and complete showing actual location of all equipment as installed. Record drawings shall be updated at least monthly. Record drawings shall show outlet from which homeruns are taken, and location of all junction boxes and access panels. These drawings shall be available to Architect/Engineer field representative.

B. Any addenda sketches and supplementary drawings issued during course of construction shall be incorporated in drawings.

C. At completion, submit an accurate checked set of drawings.

D. After approval of these drawings, photo reproductions of original tracings shall be revised to incorporate changes, including addenda sketches and supplementary drawings. Fitup drawings for tenant areas shall also be revised in the same manner. These “as-built” photo reproductions shall be certified as correct and delivered to the Architect along with two (2) sets of black line prints and Auto CAD files on thumb drive of all changes.

1.24 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS

A. Operating Instructions: Refer to Section 01 78 00 - Furnish operating instructions to Owner’s designated representative with respect to operations, functions and maintenance procedures for equipment and systems installed. Cost of such instruction up to a full three (3) days of Electrical Subcontractor’s time shall be included in contract. Cost of providing a manufacturer’s representative at site for instructional purposes shall also be included.

B. Maintenance Manuals:

1. At completion of the project, provide four copies of complete manuals containing the following:

   a. Complete shop drawings of equipment.
   b. Operation description of systems.
   c. Names, addresses, and telephone numbers of suppliers of systems.
   d. Vendors’ P.O. numbers for equipment installed.
   e. Preventive maintenance instructions for systems.
   f. Spare parts list of system components.

2. All information shall be in one binder.
1.25 COORDINATION DRAWINGS

A. Refer to Division 01 – General Requirements, before materials are purchased or work is begun, prepare and submit to the Architect, Coordination Drawings showing the size and location of all equipment and piping lines relevant to the complete system. Ensure that these Drawings are compatible and correctly annotated and cross-referenced at their interfaces.

B. The General Trades Contractor shall be responsible for the coordination of all mechanical Plumbing, fire protection and electrical work. Before materials are fabricated or work begun, he shall submit to the Architect complete Coordination NavisWorks file and whatever medium the subcontractor uses to transmit shop drawing information to the field.

C. The NavisWorks model represents what must be installed. Any deviation from the model will be noted and incorporated into the drawings both paper and 3D. If field installation management decides to deviate from the detailed coordination drawings, they are under responsibility for all collisions, schedule, or financial issues caused by the deviation.

D. If two systems are found to have an issue that was not previously resolved in the model and both systems were drawn dimensionally correct and to origin, the issue will be resolved by a meeting of the field supervision to decide the best course of action. If an error in the 3D drawings has caused the issue, the subcontractor with erroneous drawings will be under the responsibility to find a solution.

E. The Subcontractors will be solely responsible for Quality Control and the assurance that field installation matches shop drawings.

F. Coordination Drawings shall indicate the necessary offsets for all ductwork, piping, conduit, and other items to clear the work of all other trades and to maintain the required ceiling height and partition layout. Each subcontractor shall indicate both top and bottom elevations of their equipment taking into account hangers, flanges, and other accessories.

G. Prepare Coordination Drawings as follows:

1. The General Trades Contractor shall require the HVAC Subcontractor to prepare original Drawings showing all his/her equipment, ducts, and piping.
2. The General Trades Contractor shall then require the PLUMBING Subcontractor to indicate all Plumbing piping and heating lines.
3. The General Trades Contractor shall then require the FIRE PROTECTION Subcontractor to indicate all his/her equipment and piping.
4. The General Trades Contractor shall then require the ELECTRICAL Subcontractor to indicate all his/her equipment and conduit.
5. The General Trades Contractor shall resolve conflicts and then submit these Drawings to the Architect for review.

H. Coordination Drawings shall bear the signature of all Subcontractors involved indicating that all space conditions have been satisfactorily resolved. In addition, the Drawings shall bear the Contractor’s stamp bearing the notation “Drawings Have Been Checked and Coordinated With All Trades”. Drawings without these notations will not be accepted by the Architect.

I. If any space conflicts cannot be resolved by the Contractor, he shall immediately notify the Architect and request disposition of the conflict.
J. Coordination Drawings are for the Contractor’s and Architect’s use during construction and shall not be construed as replacing any Shop, “As-Built”, or Record Drawings required elsewhere in these Contract Documents.

K. Architect’s review of Coordination Drawings shall not relieve the Contractor from his overall responsibility for coordination of all work performed pursuant to the Contract or from any other requirement of the Contract.

L. Refer to Section 01 78 00 – CLOSEOUT SUBMITTALS for further requirements and procedures.

1.26 RETURN AIR PLENUM

A. All wiring above suspended ceilings shall be “UL Listed” plenum rated cable or wiring shall be installed in conduit.

1.27 COMMUNICATIONS AND IESS SYSTEM, AND BDA SYSTEM PROVISIONS

A. The work shall be so performed so that the progress of the entire building construction, including all other trades, shall not be delayed and not interfered with. Materials and apparatus shall be installed as fast as conditions of the building will permit and must be installed promptly when and as directed.

1. The Electrical Contractor shall be responsible for furnishing and installing: conduits from each door strike, latch, mag lock, door contact, electric closures, card reader, etc. to an accessible ceiling space. Provide power and fire alarm interface at each power supply, door controller requiring same.

B. Responsibilities of the Communications System, and BDA System Contractors: The Communications System Contractor and BDA System Contractor, will be responsible for furnishing, installing, wiring, programming, troubleshooting, training and warranty service of all cabling, terminal equipment, headend equipment, as specified in Section 27 00 00, 28 00 00, and Paragraph 2.28 of Section 26 00 10 for completely operational systems.

C. The work shall be so performed so that the progress of the entire building construction, including all other trades, shall not be delayed and not interfered with. Materials and apparatus shall be installed as fast as conditions of the building will permit and must be installed promptly when and as directed.

D. Responsibilities of the Electrical Contractor: The Electrical Contractor shall be responsible for furnishing and installing all related building preparation including, but not limited to: outlet boxes with plaster rings, 120 volt, power, surface raceways, conduits with bushings, conduit stubs with bushings, sleeves with bushings (all conduits, stubs, sleeves, etc. shall be brought to an accessible ceiling of the same floor), backboxes, plaster rings, pull strings, j-hooks (every 5 feet along main paths to communications closets), bonding, grounding, core drilling, cutting, environmental seals, seismic supports, etc., for a completely operational system, as specified. Special backboxes furnished Security System Contractor and Communications System Contractor, shall be installed by Electrical Contractor.

1. The Electrical Contractor shall be responsible for furnishing and installing: conduits from each door strike, latch, mag lock, door contact, electric closures, card reader, etc. to an accessible ceiling space. Provide power and fire alarm interface at each power supply, door controller requiring same.
E. Responsibilities of the Communications System Contractors: The Communications System Contractor will be responsible for furnishing, installing, wiring, programming, troubleshooting, training and warranty service of all cabling, terminal equipment, headend equipment, as specified in Section 27 00 00 for a completely operational system.

F. Responsibilities of the Integrated Electronic Security Systems (IESS) Contractor will be responsible for furnishing, installing, wiring, programming, troubleshooting, training, and warranty service of all cabling, terminal equipment, and head-end equipment for a completely operational system.

G. Keep fully informed as to the shape, size and position of all openings required for all apparatus and give information in advance to build openings into the work.

H. All distribution systems which require pitch or slope such as plumbing drains, steam and condensate piping shall have the right of way over those which do not. Confer with other trades as to the location of pipes, ducts, lights and apparatus and install work to avoid interferences.

I. Coordinate exact locations and roughing in dimensions of all work before installation and make all final connections as required. Any changes required to avoid interference or to provide adequate clearances for Code and maintenance requirements shall be made at no additional costs.

J. Structural elements of the project shall not be relocated, altered or changed to accommodate the work without written authorization from the Architect.

K. Work that is installed before coordination with other trades, or that causes interference with the work of other trades shall be changed to correct condition.

L. Obtain a complete set of Project Drawings and Specifications for coordination and to determine the full scope of work.

M. Attend project coordination meetings to coordinate work of this Section, work of other trades and project and phasing retain a complete set of Project Drawings and Specifications for coordination and to determine the full scope of work.

1.28 TEMPORARY LIGHT & POWER

A. Refer to Section 01 50 00– TEMPORARY FACILITIES AND CONTROLS.

1.29 TRADE RESPONSIBILITY FOR INTERCONNECTIONS MATRIX

<table>
<thead>
<tr>
<th>Device</th>
<th>Furnished By</th>
<th>Installed By</th>
<th>Power Wiring</th>
<th>Control Wiring</th>
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<th>Notes</th>
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<tbody>
<tr>
<td>Smoke Detectors (Area type)</td>
<td>26 00 10</td>
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<td>26 00 10</td>
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<td>Smoke Detectors &amp; Carbon Monoxide Detectors (Duct mounted)</td>
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<td>Furnished By</td>
<td>Installed By</td>
<td>Power Wiring</td>
<td>Control Wiring</td>
<td>Fire Alarm Wiring</td>
<td>Notes</td>
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<tr>
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<tr>
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<tr>
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<td>Box Mfr</td>
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<tr>
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<td>Box Mfr</td>
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<td>230000 (ATC)</td>
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<td>26 00 00 &amp; 23 00 00</td>
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<tr>
<td>VFDs at EFs &amp; Pumps</td>
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<td>26 00 00</td>
<td>23 00 00 (ATC)</td>
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</table>
### Notes:

1. Division 230000 and Division 230000 (ATC) Contractors shall fully coordinate all airflow damper and hydronic valves sizes and quantities.
2. Smoke Damper and VAV Box power wiring shall be provided by Division 26 00 10 to junction box locations shown on electrical drawings; Division 230000 (ATC) Contractor shall provide final power wiring from junction box to end device location.
3. Division 26 00 10 Contractor shall provide all line-voltage power wiring required for meters; Division 230000 (ATC) Contractor shall provide all low-voltage power wiring required for meters.
4. Division 26 00 10 shall provide power at main DDC Panel. Division 230000 (ATC) shall provide power to all other DDC Panels.
5. Power wiring for RTU, HV, MAU, AHU & ERV shall be a single point connector made by the Electrical Contractor (26 00 00). Integral wiring and connections shall be provided by Division 23 00 00.
6. Division 26 00 10 shall provide VFDs for all EFs and pumps with exception to EFs and/or pumps provided with ECM motors. ECM motors are specified in Division 23 00 00 and provided by Division 23 00 00 coordinate with mechanical schedules and specifications.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

A. Product specifications are written in such a manner so as to specify what materials may be used in a particular location or application and therefore does not indicate what is not acceptable or suitable for a particular location or application. As an example: non-metallic sheathed cable is not specified; therefore, it is not acceptable.
B. For purpose of establishing a standard of quality and not for purpose of limiting competition, the basis of this Specification is upon specified models and types of equipment and materials, as manufactured by specified manufacturers.

C. In all cases, standard cataloged materials and systems have been selected. Materials such as lighting fixtures specially manufactured for this particular project and not part of a manufacturers' standard product line will not be acceptable. In the case of systems, the system components shall be from a single source regularly engaged in supplying such systems. A proposed system made up of a collection of various manufacturers' products will be unacceptable.

D. Where Specifications list manufacturers' names and/or "as approved" or "Equal approved by Architect", other manufacturers' equipment will be considered if equipment meets Specification requirements and has all features of the specified items as are considered essential by Architect.

E. All material shall be new and shall be UL listed.

2.2 RACEWAYS AND FITTINGS

A. Raceways - General:
1. No raceway shall be used smaller than ¾ in. diameter and shall have no more than four 90 deg. bends in any one run, and where necessary, pull boxes shall be provided. Only rigid metal conduit or intermediate metal conduit is allowed for slab work. Cable systems, if allowed to be used by other sections of this specification, shall not be used exposed or in slabs, whether listed by "UL" for such use or not.
2. Rigid metal conduit conforming to, and installed in accordance with, Article 344 shall be heavy wall zinc coated steel conforming to American Standard Specification C80-1 and may be used for service work, exterior work, slab work, and below grade level slab, wet locations, and in mechanical rooms for drops down to equipment from elevations below eight feet and also where raceway may be subject to mechanical damage.
3. Intermediate metal conduit conforming to, and installed in accordance with, Article 342, may be used for all applications where rigid metal conduit is allowed by these specifications.
4. Electrical Metallic Tubing (EMT), conforming to, and installed in accordance with, Article 358 shall be zinc coated steel, conforming to industry standards, may be used in masonry block walls, stud partitions, above furred ceilings, where exposed but not subject to mechanical damage, and may be used for fire alarm work.
5. Surface metal raceways conforming to, and installed in accordance with, Article 386 may be used only where raceways cannot be run concealed, and then, if only specifically approved.
6. Flexible metal conduit shall be used for final connections to recessed lighting fixtures from above ceiling junction boxes and for final flexible connections to motors and other rotating or vibrating equipment. Liquid tight flexible metal conduit shall be used for the above connections which are located in moist locations. All flexible connections shall include an insulated grounding conductor.
7. Rigid non-metallic conduit may be used for underground electric and telephone services outside the foundation wall and also below slab and shall be polyvinyl chloride (PVC) schedule 40, 90 deg. C. Rigid metal conduits shall be used thru-foundation walls and thru-slab. Below slab conduits do not require concrete encasement.
8. PVC Schedule 40 may be used for below slab circuits within building confines. Below slab rigid non-metallic conduits do not require concrete encasement. Rigid non-metallic conduits may be used for below slab feeders and branch circuits, but shall not be used in slabs, nor for elbows which penetrate slabs. Raceways and fittings shall be produced by same manufacturer.
9. PVC schedule 40 may also be used for underground branch circuits outside the foundation wall.

10. PVC schedule EB conduit will be used as indicated on Electrical Site Plan, and where encased in concrete.

11. Acceptable manufacturers:
   a. Pittsburgh Standard Conduit Company
   b. Republic Steel and Tube
   c. Youngstown Sheet and Tube Company
   d. Carlon
   e. Or equal

12. Fittings:
   a. Provide insulated bushings on all raceways 1 inch diameter or larger.
   b. Manufacturer's standard fittings shall be used for raceway supports.
   c. Expansion Fittings: Expansion fittings shall be used where structural and concrete expansion joints occur and shall include a ground strap. Bond separate buildings in accordance with code.
   d. Couplings for rigid metal and intermediate metal conduit shall be threaded type.
   e. Threadless fittings for EMT shall be watertight compression type or set-screw type (dry-locations). All fittings shall be concrete tight. No diecast fittings allowed except for raceways larger than 1 inch diameter.
   f. Cable supports in vertical raceways shall be of the split wedge type. Armored cable supports for vertical runs to be of wire mesh basket design.
   g. Wall entrance seals shall be equal to O.Z. Gedney type "WSK".
   h. Couplings, elbows and other fittings used with rigid nonmetallic conduit shall be of the solvent cemented type to secure a waterproof installation.
      1) Acceptable manufacturers:
         a) O.Z.
         b) Crouse Hinds
         c) Appleton
         d) EFCOR
         e) Steel City
         f) Or equal

B. Outlets, Pull and Junction Boxes:

1. Outlets:
   a. Each outlet in wiring or raceway systems shall be provided with an outlet box to suit conditions encountered. Boxes installed in normally wet locations or surface mounted shall be of the cast-metal type having hubs. Concealed boxes shall be cadmium plated or zinc coated sheet metal type. Old work boxes with Madison clamps not allowed in new construction. Thru the wall boxes are not permitted.
   b. Each box shall have sufficient volume to accommodate number of conductors in accordance with requirements of Code. Boxes shall not be less than 1-1/2 in. deep unless shallower boxes are required by structural conditions and are specifically approved by Architect. Ceiling and bracket outlet boxes shall not be less than 4 in. octagonal except that smaller boxes may be used where required by particular fixture to be installed. Flush or recessed fixtures shall be provided with separate junction boxes when required by fixture terminal temperature requirements. Switch and receptacle boxes shall be 4 in. square or of comparable volume.
   c. Far side box supports shall be Caddy J-1A.
   d. Acceptable manufacturers:
      1) Appleton
      2) Crouse Hinds
      3) Steel City
2. Pull and Junction Boxes: Where indicated on plans, and where necessary to terminate, tap off, or redirect multiple raceway runs or to facilitate conductor installation, furnish, and install appropriately designed boxes. Boxes shall be fabricated from code gauge steel assembled with corrosion resistant machine screws. Box size shall be sized per Code. Pencell fiberglass handholes are allowed as a substitute for Quazite handholes with H20 wheel load covers.

3. Boxes in moist or wet areas shall be galvanized type. Boxes larger than 4-11/16 inches square shall have hinged covers. Boxes larger than 12 inches in one dimension will be allowed to have screw fastened covers, if a hinged cover would not be capable of being opened a full 90 degrees due to installation location.
   a. Acceptable Manufacturers:
      1) Brasch
      2) Hoffman
      3) Keystone
      4) Lee Products Co.
      5) McKinstry Inc.
      6) Eldon Inc.
      7) Or equal

2.3 CONDUCTORS

C. All conductors shall be a minimum size of #12 AWG except for control wiring and fire alarm wiring where #14 AWG may be used. For all exit sign circuits, normal/emergency and/or emergency only circuits, exterior lighting circuits, and also where distance from panelboard to first outlet exceeds 80 ft. at 120 volts, #10 AWG shall be minimum size wire allowed. All feeder and branch circuit conductor shall be color coded as follows:
   1. 208Y/120V   Phase A Black
   2. 208Y/120V   Phase B Red
   3. 208Y/120V   Phase C Blue
   4. Grounded Conductor 120/208 White
   5. Equipment Ground 120/208 Green
   6. Isolated Ground 120/208 Green with Orange Trace

D. All conductors not installed in accordance with color scheme shall be replaced. All conductors larger than #6 AWG must be identified with colored tape.

E. Comply with CMR 527, Massachusetts Electrical Code.

F. Comply with Underwriter's Laboratories (UL) standards:
   1. UL 4:  Armored Cable.
   3. UL 83:  Thermoplastic-Insulated Wires and Cables.
   4. UL 486A:  Wire Connectors and Soldering Lugs for Use with Copper Conductors.
   5. UL1569: Metal -Clad Cables.

G. Comply with NEMA WC-5: Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

H. Connections throughout the entire job shall be made with solderless type devices.
   1. For #10 AWG and smaller: spring type.
   2. For #8 AWG and larger: circumferential compression type.
3. Acceptable manufacturers:
   a. 3M "Scotchlock"
   b. IDEAL "Wingnut"
   c. BURNDY
   d. MAC
   e. Or equal

4. Any splices made up in ground mounted pull boxes shall be resin cast waterproof type or waterproof pressure type, as manufactured by King Technology, St. Louis, MO.

I. Conductors shall be copper, soft drawn, and annealed of 98 percent conductivity. Conductors larger than #10 AWG shall be stranded; #10 AWG and smaller shall be solid. Conductors shall be insulated for 600 volts and be of following types:
   1. All conductors shall have heat/moisture resistant thermoplastic insulation type THHN/THWN (75 degrees C) except as follows:
      a. In sizes #1 AWG and larger: Crosslinked polyethylene insulation type XHHW (75 degrees C – 90 degrees C) may be used.
      b. Fire alarm system conductors shall be #14 AWG, type THHN, solid. Color coding of fire alarm conductors shall be in accordance with fire codes.
      c. Fixture whips #16AWG type "SF".

J. Stranded conductors for all wiring systems except fire alarm will be allowed if installed and terminated as specified under Execution Section.

K. Mineral-Insulated Metal-Sheathed Fire-Resistive Cables (Type MI) - Cables shall consist of a factory assembly of one or more solid copper conductors insulated with highly-compressed magnesium oxide and enclosed in a seamless, liquid-and-gas-tight continuous copper sheath. Cables shall be rated for 600 volts and less. Cables shall comply with Article 332 of the National Electrical Code. Cables shall be classified by Underwriters Laboratories, Inc. as having a 2-hour fire resistive rating. Cable terminations shall be made with UL listed mineral-insulated cable fittings. Approved Manufacturer - Pyrotenax USA, Inc. or approved equal.

L. Type MC Cable may be used for concealed branch circuits in hollow spaces where allowed by code if installed and terminated as specified under Execution Section. Armor shall be galvanized steel and shall be UL listed for 2 hour fire wall penetration. Aluminum armor is not acceptable.

M. Type MC Cable may also be used for fire alarm where concealed and allowed by Code. Armor shall be red.

N. Acceptable manufacturers:
   1. AFC Cable Systems
   2. American Wire & Cable
   3. Cerro
   4. Cornish
   5. Crescent
   6. General Cable
   7. Okonite
   8. Or equal
O. Installation of conductors and cables

1. Install all power and 120 volt control wire and cable in approved raceways. When low tension wiring is run exposed, install it in conduit. Plenum rated low tension cable may be used for installation above suspended ceilings where it is allowed by the Code and is allowed in the specification for the specific system.
   a. Wire Size:
      1) Install minimum No. 12 AWG for power and lighting circuits.
      2) Install minimum No. 10 AWG for 120 volt 20 ampere branch circuits of 75 feet to 150 feet length, and minimum No. 8 AWG for the circuits of 150 feet to 250 feet unless otherwise shown on the drawings or required by the equipment shop drawings.
      3) Install minimum No. 10 AWG for 277 volt 20 ampere branch circuits of more than 150 feet unless otherwise shown on the drawings.

2. Metal clad cable type MC may be used for branch circuit wiring above suspended ceilings and for device wiring in the metal stud partitions. MC cable shall not be used for a termination at the panels (homeruns) and where they run exposed. Any wiring associated with Smoke control systems can not be installed in MC cable as it does not meet 780 CMR Section 909.12.1.

3. Bundle conductors #10 and smaller in branch circuit panelboards, signal cabinets, signal control boards in switchboards and motor control centers.

4. Homerun Circuits:
   a. Follow homerun circuit numbers shown on the drawings to connect circuits to the panelboards. Where homerun circuit numbers are not shown on the drawings, divide similar types of connected loads among phase busses so that currents in each phase are within 10% of each other during normal usage.
   b. Wire multi-wire branch circuit homerun with two or three single phase and one common neutral conductor to a panel in such manner that each phase circuit is fed from the adjacent circuit breakers. Do not combine circuits so that any homerun has more than three circuits (total of five wires) installed in one conduit, unless the circuit conductors are de-rated in strict accordance with the referenced Electrical Code.
   c. Branch circuit wiring in the classrooms, laboratories and offices shall be provided with a dedicated neutral conductor for each phase conductor.

5. Properly group feeders, branch circuit and auxiliary system wiring passing through pull boxes and/or being made up in panelboards; neatly bind each group of wires together with plastic cable ties, and trim loose ends of the ties.

6. Peel branch circuits and auxiliary system wiring out of the wiring gutters at the terminal cabinet and panels at 90 degrees to circuit breakers and terminal lugs before making connections.

7. Color code conductors No. 6 AWG and larger by applying colored plastic tape at ends and where connections and splices are made. Wrap tape around the conductor three complete turns.

8. Splices and Terminations:
   a. Make splices and joints by means of UL-listed, solderless connectors rated 600 volt, of sizes and types required by manufacturer's recommendations, with temperature ratings equal to that of wire.
   b. Attach copper wire to panelboards, switchboards, disconnect switches and other electrical equipment by means of bolt-on lugs with hex screws. Properly size lugs; do not cut strands from a conductor in order to fit conductor into a lug.
   c. Connectors for cables 250 MCM and larger shall have two clamping elements and terminals for bus connections shall have two bolt holes.
9. **Identification:** Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems." Label feeder and branch circuits in pull and junction boxes, handholes and at cable terminations in the panelboards, motor control centers, and switchboards. Use non-ferrous tags or labels stamped or printed to correspond with markings on the drawings or marked so that feeder or cable may be identified readily. If suspended tags are provided, attach with nylon line or cable lacing.

10. Connect branch circuits to the breakers in multi-phase panelboards required to balance loads.

11. Provide handle ties for multiwire branch circuits as required in the NEC

12. **Low Tension Cables:** Provide separation from power wiring and lighting fixtures as follows:
   a. Lighting fixtures - at least 6 inches.
   b. Power branch circuit wiring with MC type cable - at least 12 inches.
   c. Power branch circuit wiring in metal conduit - at least 6 inches.

13. When low-tension cables are not in conduit or trays, support cables from the deck and/or beams, spacing supports no farther apart than 6 ft.-0 in. on center. Provide hangers, clips or other approved method of grouping the cables and keeping them away from other systems. Take care to ensure that ties, clips and other support devices do not compress the cable or damage cable insulation; use J-hooks whenever possible.

14. **Cable Supports:**
   a. Provide cable supports for vertical feeders required by the referenced Electrical Code.
   b. Support vertical feeders at each floor level.
   c. Support and secure metal-clad cable Type MC at intervals not exceeding 6 feet and within 12 inches from every outlet box, junction box or cabinet.
   d. Support metal clad cable Type MC with cable supports equal to Caddy WMX-6, MX-3, and clamps equal to Caddy 449. Where cables are supported by the structure and only need securing in place, then cable ties will be acceptable.

15. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

16. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

17. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

18. For wiring in high temperature areas or high temperature equipment (i.e. boiler rooms, water heaters/boosters), furnish conductors for 90°C dry and wet rating.

**2.4 ACCESS PANELS**

A. Coordinate and Furnish access panels for access to concealed junction boxes and to other concealed parts of system that require accessibility for operation and maintenance. In general, electrical work shall be laid out so access panels are not required.

B. Access panels shall be located in a workmanlike manner in closets, storage rooms, and/or other non-public areas, positioned so that junction can be easily reached and size shall be sufficient for purpose (minimum size 12 in. x 12 in.). When access panels are required in corridors, lobbies, or other habitable areas, they shall be located as directed by the Architect. Submit layout and locations for approval.

C. Access panels once coordinated with the architect and the G.C. shall be furnished by this trade contractor to the G.C. for installation. Coordinate all locations so that the finish trades can locate the rough openings appropriately.

D. Furnish Access panels in compliance with Section 08 31 00.
E. Furnish access panel shop drawings.

2.5 SLEEVES, INSERTS, AND OPENINGS

A. Sleeves: Provide sleeves of proper sizes for all openings required in concrete floors and walls. Sleeves passing through floors shall be set with top of sleeve 1 in. above finished floor. Core drilling will also be acceptable if in accordance with any structural standards. Any unsleeved openings shall be waterproofed.

B. Inserts: Provide inserts or other anchoring devices in concrete and masonry construction as required to support raceways and equipment.

C. Openings: Where an opening is required in concrete slabs to allow passage of a multitude of raceways, give adequate notice to General Trades Contractor so he may box out opening in form work.

D. Any openings through fire rated surfaces shall be closed off with fireproofing materials providing the same rating as the surface penetrated.

Manufacturers:
1. Specified Technologies Inc.
2. Thomas & Betts
3. International Protective Coatings Corp.
4. 3M Fire Protection Products
5. Or equal

2.6 FLOOR OUTLETS (FLUSH TYPE)

A. Section includes flush floor boxes equal to Wiremold RFB Series. Provide appropriate floor box model that meets the intent of what is shown on the drawings.

B. Quality Assurance
1. Electrical Raceways and Components: Comply with requirements of applicable local codes, NEC, UL, and NEMA Standards pertaining to raceways and components. Listed and labeled in accordance with NFPA 70, Article 100.

C. Floor Boxes
1. RFB4 and RFB4-4DB Series Floor Boxes: Manufactured from stamped steel and approved for use on above grade floors. The box shall be 12-3/4" L x 10" W x 3-7/16" H [324mm x 254mm x 87mm]. Provide the box with four (4) independent wiring compartments that allow capacity for up to four (4) duplex receptacles, communication and/or audio/video services. The RFB4 Series Box shall permit tunneling from end power compartment to end power compartment. The RFB4-4DB Series Box shall permit tunneling from adjacent or opposite compartments. Two (2) of the four (4) compartments shall have a minimum wiring capacity of 16.4 cu in [269cu cm], one (1) compartment shall have a minimum capacity of 32.3 cu in [529cu cm], and one (1) compartment shall have a minimum capacity of 50 cu in [820cu cm]. Four (4) compartments shall have a minimum of two (2) inches of space behind the device plates. The box shall include the following number of conduit knockouts: one (1) 1/2-inch [12.7mm], three (3) 1-inch [25mm], six (6) 3/4-inch [19.1mm], and six (6) 1-1/4-inch [32mm]. The box shall be fully adjustable, providing a maximum of 1-7/8-inch [47.7mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics® workstation connectivity outlets and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.
2. **RFB4-CI-1 and RFB4-CI-NA Series Floor Boxes:** Manufactured from cast-iron and approved for use on grade and above grade floors. The box shall be 14-1/2" L x 11-7/8" W x 3-7/16" H [368mm x 302mm x 87mm]. Provide the box with four (4) independent wiring compartments that allow capacity for up to four (4) duplex receptacles and/or communication services. The box shall permit tunneling from adjacent or opposite compartments. Two (2) of the four (4) compartments shall have a minimum wiring capacity of 27 cu in [443cu cm], and two (2) compartments shall have a minimum wiring capacity of 36 cu in [590cu cm]. Four (4) compartments shall have a minimum of two (2) inches of space behind the device plates. The box shall include the following number of conduit hubs: four (4) 1-inch [25mm] and four (4) 1-1/4-inch [32mm]. The box shall be fully adjustable, providing a maximum of 1-7/8-inch [48mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics® workstation connectivity outlets and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.

3. **RFB4-SS Series Floor Boxes:** Manufactured from stamped-steel and approved for use on above grade floors. The box shall be 13-5/8" L x 10" W x 2-7/16" H [346mm x 254mm x 62mm]. Provide the box with four (4) independent wiring compartments that allow capacity for up to four (4) duplex receptacles, communication and/or audio/video services. The box shall permit feed through tunneling from adjacent compartments. Two (2) of the four (4) compartments shall have a minimum wiring capacity of 15.7 cu in [257cu cm] and two (2) compartments shall have a minimum wiring capacity of 31.2 cu in [511cu cm]. Four (4) compartments shall have a minimum of two (2) inches of space behind the device plates. The box shall contain the following number of conduit knockouts: two (2) 1/2-inch [12.7mm], six (6) 3/4-inch [19.1mm], and eight (8) 1-inch [25mm]. The box shall be fully adjustable, providing a maximum of 1-7/8-inch [48mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics® workstation connectivity outlets and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.

4. **RFB4E Series Floor Boxes:** Manufactured from stamped steel and approved for use on above grade floors. The box shall be 13-1/8" L x 13-1/8" W x 4-1/16" H [333mm x 333mm x 103mm]. Provide the box with four (4) independent wiring compartments that allow capacity for up to four (4) duplex receptacles, communication and/or audio/video services. The box shall permit feed through removable barriers from adjacent compartments. Four (4) compartments shall have a minimum wiring capacity of 75 cu in [1230cu cm]. Four (4) compartments shall have a minimum of 3-1/2 inches of space behind the device plates. The box shall contain the following number of conduit knockouts: six 3/4-inch [19.1mm], ten (10) 1-inch [25mm], and eight (8) 1-1/4-inch [32mm]. The box shall have two removable knockout plates that can be replaced with a 2-inch trade size conduit hub (2HUB). The box shall be fully adjustable, providing a maximum of 2-inch [35mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics workstation connectivity outlets and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.
5. **RFB4E-OG Series Floor Boxes:** Manufactured from stamped steel and painted with a fusion-bonded epoxy designed for use on metal reinforcement bar and related accessories before encapsulation in concrete, and approved for use on grade and above grade floors. The box shall be 13-1/8" L x 13-1/8" W x 4-1/16" H [333mm x 333mm x 103mm]. Provide the box with four (4) independent wiring compartments that allow capacity for up to four (4) duplex receptacles, communication and/or audio/video services. The box shall permit feed through removable barriers from adjacent compartments. Four (4) compartments shall have a minimum wiring capacity of 75 cu in [1230cu cm]. Four (4) compartments shall have a minimum of 3-1/2 inches of space behind the device plates. The box shall contain the following number of conduit knockouts: six 3/4-inch [19.1mm], ten (10) 1-inch [25mm], and eight (8) 1-1/4-inch [32mm]. The box shall have two removable knockout plates that can be replaced with a 2-inch trade size conduit hub (2HUB). The box shall be fully adjustable, providing a maximum of 2-inch [35mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics workstation connectivity outlets and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.

6. **RFB6 Series Floor Boxes:** Manufactured from stamped steel and approved for use on above grade floors. The box shall be 13-1/8" L x 12-1/2" W x 3-1/4" H [333mm x 317mm x 83mm]. Provide the box with six (6) independent wiring compartments that allow capacity for up to six (6) duplex receptacles, communication and/or audio/video services. The box shall permit feed through tunneling from adjacent compartments. Two (2) of the six (6) compartments shall have a minimum wiring capacity of 23 cu in [376cu cm] and four (4) compartments shall have a minimum wiring capacity of 52cu in [850cu cm]. Four (4) of the six (6) compartments shall have a minimum of 3-1/4 inches of space behind the device plates and two (2) of the six (6) compartments shall have a minimum of 2-3/8 inches of space behind the device plates. The box shall contain the following number of conduit knockouts: twelve 3/4-inch [19.1mm], four (4) 1-inch [25mm], and twelve 1-1/4-inch [32mm]. The box shall be fully adjustable, providing a maximum of 1-3/8-inch [35mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics workstation connectivity outlets and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.

7. **RFB6-OG Series Floor Boxes:** Manufactured from stamped steel and painted with a fusion-bonded epoxy designed for use on metal reinforcement bar and related accessories before encapsulation in concrete, and approved for use on grade and above grade floors. The box shall be 13-1/8" L x 12-1/2" W x 3-1/4" H [333mm x 317mm x 83mm]. Provide the box with six (6) independent wiring compartments that allow capacity for up to six (6) duplex receptacles, communication and/or audio/video services. The box shall permit feed through tunneling from adjacent compartments. Two (2) of the six (6) compartments shall have a minimum wiring capacity of 23 cu in [376cu cm] and four (4) compartments shall have a minimum wiring capacity of 52cu in [850cu cm]. Four (4) of the six (6) compartments shall have a minimum of 3-1/4 inches of space behind the device plates and two (2) of the six (6) compartments shall have a minimum of 2-3/8 inches of space behind the device plates. The box shall contain the following number of conduit knockouts: twelve 3/4-inch [19.1mm], four (4) 1-inch [25mm], and twelve 1-1/4-inch [32mm]. The box shall be fully adjustable, providing a maximum of 1-3/8-inch [35mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics workstation connectivity outlets and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.
8. **RFB6E Series Floor Boxes:** Manufactured from stamped steel and approved for use on above grade floors. The box shall be 13-1/8" L x 12-1/2" W x 4" H [333mm x 317mm x 102mm]. Provide the box with six (6) independent wiring compartments that allow capacity for up to six (6) duplex receptacles, communication and/or audio/video services. The box shall permit feed through tunneling from adjacent compartments through 1-1/4-inch grommet openings. Two (2) of the six (6) compartments shall have a minimum wiring capacity of 23 cu in [376cu cm] and four (4) compartments shall have a minimum wiring capacity of 52cu in [850cu cm]. Four (4) of the six (6) compartments shall have a minimum of 3-1/4 inches of space behind the device plates and two (2) of the six (6) compartments shall have a minimum of 2-3/8 inches of space behind the device plates. The box shall contain the following number of conduit knockouts: twelve 3/4-inch [19.1mm], four (4) 1-inch [25mm], and twelve 1-1/4-inch [32mm]. The box shall be fully adjustable, providing a maximum of 1-3/8-inch [35mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics workstation connectivity outlets and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.

9. **RFB6E-OG Series Floor Boxes:** Manufactured from stamped steel and painted with a fusion-bonded epoxy designed for use on metal reinforcement bar and related accessories before encapsulation in concrete, and approved for use on grade and above grade floors. The box shall be 13-1/8" L x 12-1/2" W x 4" H [333mm x 317mm x 102mm]. Provide the box with six (6) independent wiring compartments that allow capacity for up to six (6) duplex receptacles, communication and/or audio/video services. The box shall permit feed through tunneling from adjacent compartments. Two (2) of the six (6) compartments shall have a minimum wiring capacity of 23 cu in [376cu cm] and four (4) compartments shall have a minimum wiring capacity of 52cu in [850cu cm]. Four (4) of the six (6) compartments shall have a minimum of 3-1/4 inches of space behind the device plates, and two (2) of the six (6) compartments shall have a minimum of 2-3/8 inches of space behind the device plates. The box shall contain the following number of conduit knockouts: twelve 3/4-inch [19.1mm], four (4) 1-inch [25mm], and twelve 1-1/4-inch [32mm]. The box shall be fully adjustable, providing a maximum of 1-3/8-inch [35mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics workstation connectivity outlets and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.

D. **Activation Covers**

1. **FloorPort FPCT, FPBT, and FPFFT Series Covers:** Manufactured of die-cast aluminum or die-cast zinc, and available in brushed aluminum finish and powder-coated paint finishes (black, gray, bronze, nickel and brass). Activation covers shall be available in flanged and flangeless versions. Covers shall be available with options for tile or carpet inserts, or flush covers. The cover’s hinge shall allow for the cover to open 180 degrees. The furniture feed covers shall come equipped with one (1) 1-inch trade size screw plug opening and one (1) combination 1-1/4-inch and 2-inch trade size screw plug.
   a. Flanged covers shall be 7-3/4" L x 6-9/16" W [197mm x 167mm].
   b. Flangeless covers shall be 6-3/4" L x 5-9/16" W [171mm x 142mm].
2. **6CT, 6CTC, 6CFFTC, 8CTC, and 8CT Series Covers:** Manufactured of die-cast aluminum alloy and available in powder-coated gray, black, brass, nickel or bronze finish. The covers shall be available in carpet and tile versions. Provide covers with two (2) gaskets (one (1) for carpet and one (1) for tile) to go under the trim flange to maintain scrub water tightness. The activation cover for the 8CTC and 8CT series shall be 9-1/4-inch [235mm] in diameter. The activation cover for the 6CT and 6CTC series shall be 7-1/4-inch [184mm] in diameter and the activation cover for the 6CFFTC series shall be 7-3/4-inch [197mm] in diameter. The carpet covers shall be surface mounted and the tile covers shall be flush with the finished floor covering. The covers shall have spring loaded slides to allow cables to egress out of the unit and maintain as small an egress opening as possible.

3. The covers shall have been evaluated by UL to meet the applicable U.S. and Canadian safety standards for scrub water exclusion when used on tile, terrazzo, wood, and carpet covered floors.

**E. Communication Modules Mounting Accessories**

1. The floor box manufacturer shall provide a complete line of faceplates and bezels to facilitate mounting of UTP, STP (150 ohm), fiber optic, coaxial, and communication devices. The box shall provide a series of device mounting plates that will accommodate Ortronics workstation connectivity outlets and modular adapters, and other open system devices.

**F. Installation**

1. Strictly comply with manufacturer's installation instructions and recommendations and approved shop drawings. Coordinate installation with adjacent work to ensure proper clearances and to prevent electrical hazards.

2. Mechanical Security: Raceway systems shall be mechanically continuous and connected to all electrical outlets, boxes, device mounting brackets, and cabinets, in accordance with manufacturer's installation sheets.

3. Accessories: Provide accessories as required for a complete installation, including insulated bushings and inserts where required by manufacturer.

4. Unused Openings: Close unused box openings using manufacturer's recommended accessories.

5. Provide a minimum concrete pour depth of 3-7/16-inch [87mm] plus 1/16-inch [1.6mm] above the top of the box for the RFB4, RFB4-4DB, RFB2, and the RFB2-OG Series Boxes; 2-7/16-inch [62mm] plus 1/16-inch [1.6mm] for the RFB4-SS and RFB2-SS Series Boxes; and 3-7/16-inch [87mm] plus 13/16-inch [21mm] above the top of the box for the RFB4-Cl-1, RFB6, and RFB6-OG Series Boxes; and 4-1/16-inch [103mm] above the top of the RFB4E and RFB4E-OG Series Boxes; and 4-inch [102mm] above the top of the RFB6E and RFB6E-OG Series Boxes. Provide the box with four (4) locations to accommodate leveling for pre-concrete pour adjustment and include four (4) leveling screws for the pre-pour adjustment.

**P. Poke-Through Assemblies:**

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Hubbell.
   b. Pass & Seymour.
   c. Thomas & Betts Corporation.
   d. Wiremold
   e. Or equal
2. **Poke-Thru Assembly**
   a. **Floor Fitting**
      1) The floor fitting shall consist of an insert and an activation cover. Floor fitting shall accommodate power and communications services in a single unit. Floor fitting shall have one ¾ in. trade size channel for power and one 2” trade size channel for communication cabling. Floor fitting shall consist of intumescent fire stop material to maintain the fire rating of the floor slab and UL Listed with a fire rating of 1, 1½, & 2 hours in an unprotected reinforced concrete floor or a 1 or 2 hour rating in floors employing steel floor units and concrete topping. The floor fitting shall be suitable in concrete floor thicknesses of 2.5 in. or greater. The insert shall have 12 installation barbs that will hold the poke-thru device in the floor slab without additional fasteners.
   
   b. **Insert Body**
      1) The insert body shall allow the devices to be recessed 3.5-inches, or 2.25-inches with the use of 1 ¼ in. supplied stand-offs. There shall be complete separation of channels allowing for individual separation of power and communications services. There shall be one channel arranged such that communication cables can be conduit protected and connected with a 2-inch trade size openings to accept both rigid and flexible conduit connectors. The inserts shall consist of multiple compartments that allow for up to 2 duplex receptacles that can be wired in configurations including standard receptacles, isolated ground or up to 12 communication ports.
   
   c. **Activation Cover/ Flange Assembly**
      1) Activation covers and Flange shall be manufactured of die-cast aluminum alloy and be capable of being plated in brushed brass, satin nickel, and bronze finish, lacquer coated brushed aluminum or powder-coated in black, finishes. Flange shall be suitable for either carpet, tile, terrazzo and wood covered floors. Flange shall include a gasket adhered to the top inside surface to maintain scrub water tightness with sub plates. Flange shall include a gasket for assembly against the floor to maintain scrub water tightness. Cover assembly shall provide a single hinged access doors that rotate 180 degrees flush with flange and incorporate foam gaskets to maintain scrub water tightness by preventing water, dirt, and debris from entering the power and communication compartment. Cover assembly shall feature cable access doors which secure to the underside of the closed cover that allow each cable access door to be opened and closed independently.
   
   d. **Communication Modules Mounting Accessories**
      1) The poke-through manufacture shall have available modular inserts to facilitate mounting UTP (including Category 5, 5e, 6, 6a), STP, fiber optic, coaxial, and data/communications devices. The S1R6 series shall accommodate Extron MAAP or Extron AAP adapter plates. Where indicated provide connectivity outlets and modular inserts by Hubbell or approved equal.

Q. **FURNITURE FEEDpoke-thru Devices**
   1. **Poke-Through Assemblies:**
      a. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
         1) Hubbell.
         2) Pass & Seymour.
         3) Thomas & Betts Corporation.
         4) Wiremold
         5) Or equal
2. Classification and Use: Furniture feed poke-thru devices shall have been examined and tested by Underwriters Laboratories Inc. to meet UL514A and/or UL514C and Canadian Standard C22.2, No. 18-98 and bear the U.S. and Canadian UL Listing Mark. Furniture poke-thru devices shall also have been tested by Underwriters Laboratories Inc. and Classified for fire resistance and bear the U.S. and Canadian UL Classification Mark. Poke-thru devices are approved for use in recessed and flush floor construction and meet and exceed the UL scrub water exclusion test.
   a. Devices shall be classified for use in 1-, 1-1/2-, or 2-hour rated, unprotected reinforced concrete floors and 1-, 1-1/2-, or 2-hour rated floors employing unprotected steel floor units and concrete toppings (D900 Series designs), or concrete floors with suspended ceilings. Fire resistive designs with suspended ceilings shall have provisions for accessibility in the ceiling below the poke-thru fittings.
   b. These devices are not suitable for wet or damp locations, or other areas subject to saturation with water or other liquids such as commercial kitchens.
   c. Floor boxes shall be suitable for use in air handling spaces in accordance with Section 300-22(c) of the National Electrical Code.

3. MATERIALS
   a. RC7AFFTC Flush Furniture Feed Poke-Thru Assembly for power: Consists of an insert and activation cover. Overall poke-thru assembly length shall be 16-1/2 in. [419mm].
      1) Insert: Insert body shall have the necessary channels to provide complete separation of power and communication services. There shall be one 3/4-inch trade size channel for power and two 1/2-inch trade size channels for communication cabling. The channels shall be arranged such that communication cables can be conduit protected and connected to the insert body using a die-cast zinc conduit connector with two 1/2-inch trade size threaded openings to accept both rigid and flexible conduit connections.
         a) The body will consist of an intumescent fire stop material to maintain the fire rating of the floor slab. The intumescent material will be held securely in place in the insert body and shall not have to be adjusted to maintain the fire rating of the unit and the floor slab. Insert shall have a spring-steel retaining ring that will hold the poke-thru device in the floor slab without additional fasteners. The poke-thru insert shall also consist of one 3/4-inch trade size conduit stub and one 1-1/2-inch trade size conduit stub that are connected to the insert body. There shall also be a 24.5 cu in [402ml] stamped steel junction box for wire splices and connections. The stamped steel junction box shall also contain the necessary means to electrically ground the poke-thru assembly.


2) Activation Cover: The activation cover shall provide three conduit openings to feed modular furniture applications and provide a flush appearance. The activation cover trim flange shall be one-piece and be manufactured of forged aluminum alloy and be capable of being powder coated or plated. Coated finish is to be textured, two-stage epoxy paint in gray or black. Activation cover trim flange shall also be available in a solid brass forging and a die cast brushed aluminum finish. Aluminum and brass finish shall be a brushed finish with a lacquer sealant. The activation cover shall be seven inches [178mm] in diameter. A gasket is attached to the underside of the trim flange assembly to maintain scrub water tightness by preventing water, dirt, and dust from entering the power and communication compartments.

a) The activation cover insert shall provide one 3/4-inch NPSM threaded opening for power and two 1/2-inch NPSM threaded openings for communication to feed modular furniture workstations. Each activation cover shall also be supplied with one 3/4-inch trade size and two 1/2-inch trade size threaded conduit connectors and one (1/4-inch trade size and one 3/4-inch trade size and two 1/2-inch trade size conduit closure plugs.

b. RC9AM2TC Furniture Feed Poke-Thru Assembly for data: Consists of an insert and activation cover. Overall poke-thru assembly length shall be 10 inches [254mm].

1) Insert: There shall be one 2-inch trade size channel for all power or all communication cabling. The body will also consist of an intumescent fire stop material to maintain the fire rating of the floor slab. The intumescent material will be held securely in place in the insert body and shall not have to be adjusted to maintain the fire rating of the unit and the floor slab. Insert shall have a spring-steel retaining ring that will hold the poke-thru device in the floor slab without additional fasteners.

2) Activation Cover: The activation cover shall be manufactured of aluminum die-cast alloy and consist of a trim flange and a hexagonal service head. The activation cover shall be capable of being powder coated or plated. Finish shall be textured, two-stage epoxy paint available in a gray or black finish. A gasket is attached to the underside of the activation cover trim flange to maintain scrub water tightness. Trim flange shall have a combination 1-1/4 in. - 2 in. trade size conduit opening and closure plugs. The trim flange shall be seven inches [178mm] in diameter. All power connections must be made in a junction box below (not supplied).

R. Cleaning and Protection
1. Clean exposed surfaces using non-abrasive materials and methods recommended by manufacturer.
2. Protect boxes and fittings until acceptance.

2.7 WIRING DEVICES

A. Manufacturers:

1. Manufacturers’ Names: Shortened versions (shown in parentheses) of the following manufacturers’ names are used in other Part 2 articles:

a. Cooper Wiring Devices.
b. Hubbell.
c. Leviton.
d. Pass & Seymour.
e. Or equal

B. Straight Blade Receptacles:

1. Duplex Receptacles: Comply with NEMA WD 1, NEMA WD 6 configuration NEMA5-20R, UL 498 and FS W-C-596. Specification grade industrial series, straight-blade, 2 pole 3 wire grounding type, back and side wired, nylon face, rated for 120 volts, 20 amperes. Hubbell No.5362 or equal. Hubbell No.5362WR or equal for weather-resistant listed receptacles. Receptacles that are controlled by an automatic control device shall be marked per NEC with the international power symbol. Provide as indicated on the drawings with one controlled face and split circuit hot tab equal to Hubbell BR20C1 series.

2. Ground fault interrupter (GFI) receptacles: Duplex receptacles conforming to UL 943, specification grade heavy duty, feed-through type, rated for 120 volt, 20 amperes, NEMA 5-20R, GFI Class "A" with a sensitivity to leakage 5 milliamps, weather-resistant and tamper-resistant listed. Hubbell No. GF20LA or equal.

3. Transient-Voltage Surge-Suppressor (TVSS) Receptacles: Duplex type, NEMA 5-20R configuration, with integral transient-voltage surge protection in a minimum of 3 modes: line-to-ground, line-to-neutral, and neutral-to-ground; listed as complying with UL 1449. Hubbell HBL5362SA or equal.


5. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498. Straight blade; equipment grounding contacts connected only to the green grounding screw terminal of the device, with inherent electrical isolation from mounting strap. Hubbell CR 5253IG or equal.

6. Duplex Receptacles with Integral USB jacks, 125 V, 20 A: Specification grade, straight-blade, 2 pole 3 wire grounding type, back and side wired. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498. “USB” marking indicates USB receptacle duplex grounding type NEMA 5-20R equal to Hubbell MX20X2 or equal.

C. All standard 15 and 20 ampere, 125 and 250 volt non-locking type receptacles located 5 ft. -6 in. or below within Auditorium, Gymnasium, Pre-schools and elementary school age classrooms, medical clinic areas, dental offices and any other areas that are listed in NEC 406.12 shall be tamper resistant type receptacles whether indicated or not by the “T” marking on the drawings.

D. Exterior Outlets with Lockable Covers:

1. Provide exterior outlets with lockable covers at all exterior outlet locations. Provide GFCI Circuit Breakers on all branch circuits. Provide in-use weatherproof locking covers with cord retention. Provide Taymac MX3200 for single gang vertical MX3300 for single gang horizontal and MX6200 for double duplex.

a. Equal manufacturers

1) RACO
2) Hubbell
3) Or equal
E. Hazardous (Classified) Location Receptacles:

1. Wiring Devices for Hazardous (Classified) Locations: Comply with NEMA FB 11 and UL 1010.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Cooper Crouse-Hinds.
      2) Appleton Electric.
      3) Hubbell.
      4) KH Industries.
      5) Or equal

F. Twist-Locking Receptacles:

1. Single Convenience Receptacles, 125 V and 250 V, 20 A: Comply with NEMA WD 1, NEMA WD6 and UL 498. Hubbell HBL2310 (L5-20R), HBL2320 (L6-20R), or equal.

G. Cord Reels

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Hubbell.
   b. Cooper Crouse-Hinds.
   c. Appleton Electric.
   d. KH Industries.

2. Industrial grade retractable power cord reel with the following features:
   a. Cast Aluminum construction, including mounting base
   b. 12 position adjustable guide arm
   c. Adjustable ratchet can be engaged (positive lock) or disengaged (constant tension) as needed
   d. Adjustable ball stop
   e. 6’ Feeder Cord included
   f. White powder-coat finish
   g. Universal mounting overhead, wall or detached from bracket completely.
   h. Adjustable cable stop.
   i. Voltage 125 VAC
   j. Slip Ring Rating 600V/30A
   k. Payout End Blk Duplex/Duplex Outlet Box
   l. Feeder End 5-20P
   m. Max. Amperage 20 Amps
   n. Gauge/Conductor 12/3
   o. Cord Length 25 Feet
   q. Cord Type/Color SJO/White Cord Reel
   r. Color White
   s. Hubbell Model#HBLI25123GF220M1 or equal.
3. For WP Cord Reel provide as follows:
   a. Hubbell Model#HBLW25123 or equal.
   b. Hubbell Model#HBLPOB1 receptacle enclosure
   c. Install two duplex receptacles in receptacle enclosure.
   d. Provide GFCI type circuit breaker for all WP Cord Reels

H. Snap Switches:
1. Comply with NEMA WD 1 and UL 20.
2. Switches, heavy duty, side wired, 120/277V, 20A:
3. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way).
   b. Hubbell; C1221 (single pole), C1222 (two pole), C1223 (three way).
   c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way).
   d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way).

I. Securely fasten wiring devices in place, plumb, level, and true to finished lines and surfaces.

J. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

K. Provide gaskets on all wiring device plates where devices are on walls separating conditioned and non-conditioned spaces and exterior walls.

L. Composition material of wiring devices to be nylon with ivory finish. Outlets intended for computer use shall be grey finish, outlets on emergency shall be red finish.

M. Wall Plates:
1. Single and combination types to match corresponding wiring devices.
   a. Plate-Securing Screws: Metal with head color to match plate finish.
   b. Material for Finished Spaces: White-finish Type 302 stainless steel.
   d. Material for Unfinished Spaces: Galvanized steel.
   e. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."

2. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum.

N. Finishes:
1. Color: Wiring device catalog numbers as specified do not designate device color.
   a. Wiring Devices Connected to Normal Power System: Grey for computer circuits white for convenience receptacles other devices as selected by Architect, unless otherwise indicated or required by referenced Electrical Code or device listing.
   c. Isolated-Ground Receptacles: Orange.
2.8 LIGHTING FIXTURES

A. General

1. Submit the following in accordance with project submittal procedures:
   a. Catalog Data: Submit catalog data describing luminaires, lamps, and ballasts. Include data substantiating that materials comply with specified requirements. Arrange data for luminaires in the order of fixture designation.
   b. Performance Curves/Data:
      1) Submit certified photometric data for each type of luminaire.
      2) Submit supply-air, return-air, heat-removal, and sound performance data for air handling luminaires.
   c. Drawings: Submit shop drawings for non-standard luminaires.
   d. Calculations: Submit as requested to support equal product proposals.
   e. Warranty: Submit warranties for luminaires and for electronic ballasts.

2. All lamps, ballasts, led sources, drivers, and controls shall meet the latest utility company incentive requirements. Refer to the latest program requirements documentation and coordinate with the utility company to ensure compliance.

B. Quality Assurance

1. Comply with the National Electrical Code (NEC) and the Massachusetts Building Code (MBC) for components and installation.

2. Provide luminaires listed and labeled by a nationally recognized testing laboratory (NRTL) for the application, installation condition, and the environments in which installed.

3. Use manufacturers that are experienced in manufacturing luminaires, lamps and ballasts similar to those indicated for this Project and have a record of successful in-service performance.

4. Coordinate luminaires, mounting hardware and trim with the ceiling system.

C. Lamps

1. Furnish lamps that comply with requirements specified below and the luminaire schedule on the Drawings.

D. LED Assemblies

1. LED luminaires shall conform to UL 1598 and to UL 8250 – Safety Standard for Light-Emitting Diode (LED) Light Sources for Use in Lighting Products.

2. Products shall be lead and mercury free.

3. Photometric characteristics shall be established using IESNA LM-79-08, IESNA Approved Method for the Electrical and Photometric Measurement of Solid-State Lighting Products.

4. Color characteristics of LED luminaires shall be as follows in accordance with ANSI C78.377 – Specifications for the Chromaticity of Solid State Lighting Products.

5. LED and driver cooling system shall be passive and shall resist the buildup of debris.

6. LED luminaire output after 50,000 hours of operation shall be not less than 70 percent of the initial lumen output when determined in accordance with IESNA LM-80-08 – IESNA approved Method for Measuring Lumen Maintenance of LED Lighting Sources.

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7. LED source package electrical characteristics:
   a. Supply voltage: 120 V, 208 V, 240 V, 277 V, or 480 V as indicated on the Drawings. Provide step-down transformers if required to match driver input voltage rating.
   b. Total harmonic distortion (current): Not more than 10 percent
   c. Power factor: Not less than 90 percent
   d. RF interference: Meet FCC 47 CFR Part 15/18
   e. Transient protection: IEEE C62.41 Class A.

8. All LED Assemblies shall be provided by Osram, Phillips, GE, or equal.

E. Extra Materials

1. Furnish the following extra materials matching products installed. Package with protective covering for storage and identify with labels describing contents.
   a. Five percent of quantity of LED source packages of each type, but no fewer than two of each type.
   b. One percent of quantity of louvers and lenses of each type, but not less than two of each type.
   c. Five percent of quantity of LED drivers of each type, but not less than two of each type.
   d. Ten percent of single faced exit signs, but no fewer than ten. Include 100’ of type MC cable branch circuiting and installation labor.
   e. Ten percent of double faced exit signs, but no fewer than five. Include 100’ of type MC cable branch circuiting and installation labor.

F. Interior General:

1. Furnish interior luminaries that comply with requirements specified below, indicated on the Drawings to meet conditions of installation.
2. Metal parts shall be free from burrs and sharp corners and edges.
3. Metal components shall be formed and supported to prevent sagging and warping.
4. Steel parts shall be finished with manufacturer's standard finish applied over a corrosion-resistant primer. Finish shall be free from runs, streaks, stains, holidays or defects.
5. Doors and frames shall be smooth operating and free from light leakage under operating conditions. Relamping shall be possible without the use of tools. Doors, frames, lenses and diffusers shall be designed to prevent accidental falling during relamping and when secured in the operating position.
6. Luminaires shall have minimum reflecting surface reflectance as follows unless specified otherwise on the Drawings:
   a. White Surfaces: 85 percent
   b. Specular Surfaces: 83 percent
   c. Diffusing Specular Surfaces: 75 percent

7. Lenses, diffusers, covers and globes shall be 100 percent virgin acrylic unless specified otherwise on the Drawings. Lenses shall have 0.125 inch minimum thickness. Lenses for troffers shall be injection molded.

8. Luminaires shall conform to UL 1598 - Luminaires. Provide product with damp location listing or wet location listing by installation location.
G. Interior Accessories

1. Provide stud supports, mounting brackets, frames, plaster rings and other accessories required for luminaire installation.

2. Furnish hangers as specified below by conditions of installation:
   a. Stem hangers shall be made of 1/2-inch steel tubing with 45 degrees swivel ball hanger fitting and ceiling canopy. Finish the same as the luminaire.
   b. Rod hangers shall be made of 1/4 inch threaded zinc-plated steel rod.

3. Use NRTL-listed T-bar safety clips for lay-in luminaires.

H. Interior Installation

1. Install interior lighting system in accordance with the NEC, manufacturer’s installation instructions, approved shop drawings, and NECA National Electrical Installation Standards.

2. Have the manufacturer’s installation instructions available at the Project site.

3. Mounting heights specified or indicated on the Drawings are to the bottom of the luminaire for ceiling-mounted fixtures and to the center of the luminaire for wall-mounted fixtures.

4. Where the ceiling forms the protective membrane of a fire resistive assembly, install protective coverings over luminaires in accordance with NRTL requirements.

5. Install slack safety wires as described below for luminaires in or on suspended ceilings.
   a. Wire shall be minimum 12 gage galvanized soft annealed steel wire conforming to ASTM A641.
   b. Attach wire to the building structure directly above the attachment point on the box or luminaire; make trapezes of framing channel material to span obstacles
   c. Secure wire(s) at each end with not less than three tight turns in 1-1/2 inch.

6. Support pendant-mounted or cable-supported luminaires directly from the structure above using a 9 gage wire or an approved alternate support without using the ceiling suspension system for direct support.
   a. Install seismic restraints for pendant-mounted and cable-supported luminaires.
   b. Pendants, rods, cables, or chains 4 ft or longer shall be braced to prevent swaying using three cables at 120 degrees separation.

7. Connect luminaires in suspended ceilings using 6 ft. lengths of flexible wiring method arranged accommodate not less than 4 inch of differential seismic movement in any direction.

I. Interior Quality Control

1. Make electrical connections, clean interiors and exteriors of luminaires, install lamps, energize and test luminaires, inspect interior lighting system, and deliver spare parts in accordance with manufacturer’s instructions and NECA National Electrical Installation Standards:

2. Test electronic dimming ballasts for full range dimming capability.
   a. Check for visually detectable flicker over the full dimming range.
3. Prior to turnover to Owner, replace lamps that were installed and used during construction if more than 15 percent of their rated lamp life has been used.

J. Exterior - General

1. Furnish exterior luminaires that comply with requirements specified in this Section and in the luminaire schedule on the Drawings.
2. Luminaire photometric characteristics shall be based on IESNA approved methods for photometric measurements performed by a recognized photometric laboratory.
3. Luminaire housing shall be primarily metal.
   a. Metal parts shall be free from burrs and sharp corners and edges.
   b. Sheet metal components shall be fabricated from corrosion-resistant aluminum, formed and supported to prevent sagging and warping.
   c. Exposed fasteners shall be stainless steel.
4. Doors and frames shall be smooth operating and free from light leakage under operating conditions.
   a. Relamping shall be possible without the use of special tools.
   b. Doors, frames, lenses and diffusers shall be designed to prevent accidental falling during relamping and when secured in the operating position.
   c. Door shall be removable for cleaning or replacing lens.
5. Luminaires shall have minimum reflecting surface reflectance as follows unless scheduled otherwise:
   a. White surfaces: 85 percent
   b. Specular surfaces: 83 percent
   c. Diffusing specular surfaces: 75 percent
6. Provide lenses, diffusers, covers and globes as scheduled on the Drawings fabricated from materials that are UV stabilized to be resistant to yellowing and other changes due to aging or exposure to heat and ultraviolet radiation.
7. Doors shall have resilient gaskets that are heat-resistant and aging-resistant to seal and cushion lens and refractor.

K. Exterior Poles and Accessories

1. Furnish poles and accessories that comply with requirements specified in this Section and the luminaire schedule on the Drawings.
2. Pole, base, and anchorage shall carry the luminaires, supports, and appurtenances at the indicated height above grade without deflection or whipping.
3. Mountings, fastenings and other appurtenances shall be fabricated from corrosion-resistant materials that are compatible with poles and luminaires and will not cause galvanic action at contact points. Mountings shall correctly position luminaires to provide scheduled light distribution.
4. A reinforced access handhole shall be located in the wall of each metal pole.
5. A welded 1/2 inch grounding lug shall be accessible through the handhole of each metal pole. Grounding connection shall be designed to prevent electrolysis when used with copper ground wire.
6. Metal poles shall have anchor type bases and galvanized steel anchor bolts and leveling nuts.
7. Metal poles shall have a metal base cover that covers the entire base plate and anchorage.

8. Protect painted, anodized, or brushed pole finishes during shipment and installation. Minimum protection shall consist of spirally wrapping each pole shaft with protective paper secured with tape, and shipping small parts in boxes.

9. Aluminum poles shall be fabricated from corrosion resistant aluminum Alloy 6063-T6 or Alloy 6005-T5 for wrought alloys or Alloy 356-T4 for cast alloys.
   a. Poles shall be square or round, tapered or straight as indicated on the Drawings.
   b. Aluminum poles over 30 feet tall shall include factory-installed vibration dampers.
   c. Poles shall be seamless extruded or spun seamless type with minimum 0.188 inch wall thickness.
   d. Tops of shafts shall be fitted with a round or tapered cover.
   e. Base shall be anchor bolt mounted, made of cast 356-T6 aluminum alloy in accordance with ASTM B 108/B 108M, Standard Specification for Aluminum-Alloy Permanent Mold Castings and shall be machined to receive the lower end of shaft. Joint between shaft and base shall be welded.
   f. Hardware, except anchor bolts, shall be either 2024-T4 anodized aluminum alloy or stainless steel.

10. The poles EPA capacity shall meet the wind rating in the geographical area in which its installed. Refer to AASHTO wind map and provide appropriate wind rating with the paired light fixture. Wind rating shall be a minimum of 100MPH with 130MPH gust rating.

11. Anchor bolts shall be steel rod having minimum yield strength of 50,000 psi. The top 12 inch of the anchor bolt shall be galvanized in accordance with ASTM A153/A153M.

12. Manufacturers: Subject to compliance with requirements, provide products as scheduled or specified on the Drawings.

13. Fuses and Fuse holders
   a. Furnish fuse overcurrent protection for each pole-mounted luminaire to isolate faulted ballasts from the lighting circuit.
   b. Use 600 volt, Class CC, time-delay, current-limiting fuses.
   c. Select fuses rated between 200 percent and 300 percent of the luminaire ballast or driver maximum current.
   d. Manufacturer: Bussman “LP-CC” or approved equal.

14. Furnish in-line fuse holders for installation in pole hand hole or transformer base.
   a. Use non-breakaway type fuse holders unless breakaway poles are indicated on the Drawings.
   b. Use breakaway type fuse holders where breakaway poles are indicated on the Drawings.
   c. Load and line terminal sizes and types shall correspond to line and load conductor sizes and quantities.
   d. Both breakaway and non-breakaway fuse holders shall have insulating boots.
   e. Manufacturers: Ferraz Shawmut “FEC” for phase conductor(s), “FEBN” for neutral conductor, or approved equal.

2.9 ELECTRICAL POWER EQUIPMENT

A. Motor Controls - Manual and Magnetic:

1. Individually-mounted magnetic starters shall be NEMA rated across-the-line type with thermal overload on each phase, single-speed, two-speed, or reduced voltage start as indicated.
2. Motor Starters shall be furnished by Electrical Sub-Contractor unless part of package mechanical equipment such as rooftop units.

3. Starters shall be of maintained contact type, of size and type required for particular motor horsepower and voltage. Minimum size starter to be size 1 FVNR, unless noted otherwise.
   a. Starters shall have OL reset button, green push-to-test type pilot light to indicate "ON", and "HAND-OFF-AUTO" switch in cover.
   b. Starters to have 120 volt control transformers with fused output being provided for those units operating on 277/480 volt system.
   c. Provide Class 20 fixed heater overloads with auto/manual reset.
   d. Provide four (4) sets of auxiliary contacts of convertible type N.O. to N.C. for each starter.
   e. Motor starters shall have NEMA I enclosures. Those in wet locations shall be NEMA 3R.
   f. Manufacturers:
      1) Westinghouse
      2) Square D/Groupe Schneider
      3) Siemens
      4) Allen Bradley
      5) General Electric
      6) Or equal

4. Manual motor starters shall have pilot lights and shall be furnished with thermal overloads on each phase.

B. Motors: Each motor shall have disconnect switch and starter provided under this section.

1. Provide motor terminal boxes for each motor not furnished with same.

C. Disconnect Switches:

1. Disconnect (safety) switches shall conform to industrial standards of NEMA, be UL listed and shall be heavy duty type, quick-make, quick-break type with interlocking cover mechanism and provisions for padlocking switch handle in "OFF" position. Three pole toggle switches are not acceptable as substitute for disconnect switches.

2. Disconnect switches shall be of fused or unfused type as indicated with number of disconnecting poles indicated. The grounded conductor shall not be switched. Switches for use with current limiting fuses shall be rejection type and those used in conjunction with motors shall be horsepower rated. Provide oversize termination lugs if required by conductor size.

3. Enclosures shall be of proper NEMA type for intended location and shall be phosphate coated or equivalent code gauge galvanized sheet steel with ANSI #24 dark gray baked enamel finish.

4. Manufacturers:
   a. Westinghouse
   b. Square D/Groupe Schneider
   c. Siemens
   d. Allen Bradley
   e. Or equal
D. Fuses:

1. Provide a complete set of fuses for each item of fusible type equipment.
2. Turn over to authorized representative of Owner upon completion a spare set of fuses of each different type and ampere rating installed. These spares shall be bound with twine and tagged.
3. Secondary system fuses, rated at 600 volts or less, shall be UL listed and constructed in conformance with the applicable standards set forth by NEMA and ANSI. All fuses of a particular class shall be of same manufacturer.
4. All fuses in distribution panelboards and switchboards shall be class "L" above 600 amperes and class "RK1" for 600 amperes and below.
5. Main, Feeder, and Branch Circuits:
   a. Circuits 601 amperes and above shall be protected by (Bussmann type KRP-C LOW-PEAK) current limiting time delay fuses.
   b. Circuits 0-600 amperes shall be protected by (Bussmann "LOW-PEAK" dual element), time delay current limiting fuses, LPN-RK (250 volts), LPS-RK (600 volts), UL class RK-1.
6. Manufacturers:
   a. Bussmann, Division of McGraw
   b. Gould/Shawmut
   c. GEC-ALSTHOM
   d. Or equal

2.10 ELECTRICAL SYSTEM CONTROLS AND INSTRUMENTS

A. Provide a complete power system consisting of branch circuits, motor disconnect switches, pushbutton stations, motor starters, and other devices to connect up and leave in operating condition each piece of electrically operated equipment provided either under this section or other Divisions.

B. All control wiring, not indicated in the electrical specifications or not shown on electrical drawings, will be provided by Temperature Control Subcontractor.

2.11 GROUNDING SYSTEM

A. All equipment and systems shall be grounded. Refer especially to NEC Section 250 Requiring Connections to Building Steel, Foundation, Water Service, and Interior Piping. Provide transformer pad grounding in accordance with utility company standards.

B. The grounded conductor shall be supplemented by an equipment grounding system.

C. The equipment grounding system shall be installed so all conductive items in close proximity to electrical circuits operate continuously at ground potential and provide a low impedance path for ground fault currents.

D. Grounding conductors shall be so installed as to permit shortest and most direct path to ground.

E. Maximum measured resistance to ground of 5.0 ohms shall not be exceeded. Ground separately derived systems (dry type transformers) in accordance with Article 250-30 by grounding neutral to transformer ground lug and providing insulated grounding electrode conductor to nearest effectively grounded building steel or, if unavailable, to nearest available effectively grounded metal water pipe.
F. Equipment grounding conductors and straps shall be sized in compliance with Code Table 250-122.

G. Grounding conductors shall be insulated with green color. Grounding conductors for use on isolated ground receptacles shall be green with trace color to differentiate between normal ground conductors.

H. Branch circuits shall consist of phase and grounded conductor installed in common metallic raceway. All receptacle circuits shall have dedicated neutrals. All circuits shall have a separate insulated grounding conductor installed. Any flexible cable system or non-metallic raceway system shall have an insulated grounding conductor. Any cable system for use on isolated ground circuits shall have both an isolated ground conductor as well as an equipment ground conductor, both of which shall be insulated.

I. Each electrical expansion fitting shall be furnished with a bonding jumper. Provide grounding bushings and ground connections for all raceways terminating below equipment where there is no metal-to-metal continuity.

J. Continuity between all metallic and nonmetallic raceway systems and equipment shall be maintained.

K. Outdoor lighting fixtures shall be grounded and bonded in common with building system via a separate grounding conductor.

L. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

M. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

N. Ground Rods: Drive rods until tops at least 6 inches below finished floor or final grade, unless otherwise indicated. Interconnect ground rods with grounding electrode conductor below grade.

O. Dry type transformer: Install an insulated grounding conductor from a transformer neutral to the building steel by means of copper wire, as scheduled on the drawings.

P. Grounding and Bonding for Piping:
   1. Metal Water Service Pipe: Install insulated copper grounding conductors in conduit, from a grounding bus of the building's main service equipment to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
   2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
   3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

Q. Refer to Technology Specifications for additional grounding requirements.
R. Refer to Motorola R56 for communications systems grounding requirements.

2.12 PANELBOARDS

A. Panelboards shall be dead-front, door in door safety type equipped with single or multi-pole circuit breakers suitable for 120/208 volt, 3 phase, 4 wire operation.

B. Buses shall be copper. Panelboards shall have a circuit directory card mounted in a frame with plastic cover on inside of door. Panelboards to have a copper ground bus with terminals for each circuit. Panelboards serving isolated ground receptacles shall have a separate ground bus for terminations of the isolated grounds. The isolated ground bus shall be mounted to the panel tub via non-conducting means with a separate grounding conductor run to the normal panel ground bus. Provide oversize lugs for any termination requiring same due to oversize conductors. Provide 200% neutral buses on all 120/208 volt panelboards.

C. Cabinets shall be minimum of 20 inch wide and be made of code gauge steel. Surface type shall be ordered without knockouts.

D. Trims shall be made of code gauge steel, surface or flush as indicated. Panelboards shall be keyed alike. Trims shall be provided with full length piano hinge on one side, and secured to tub with sufficient quantity of latches opposite the hinge side to allow trim to fit flush with tub and when released, allow full access to wiring gutters. Inner door shall allow access to circuit breakers only.

E. Panelboards shall be of the following types with minimum circuit breaker frame sizes listed below. Refer to schedules for larger circuit breaker frame sizes due to fault current availability. Square D is the Basis of Design.

1. 120/208 volt, three phase, four wire. Symmetrical interrupting capacity 65,000 AIC.
   Style
   Westinghouse type PRL-1 BAB Breakers (bolt-on)
   Square D type NQOD QOB Breakers (bolt-on)
   Siemens type CDP-7 BQ Breakers (bolt-on)
   Or equal

2. Distribution Panels:
   a. Where scheduled as circuit breaker type, symmetrical interrupting capacity 65,000 AIC (series rated).
   b. Westinghouse type PRL-3 FD Breakers
   c. Square D I-Line type FA Breakers
   d. Siemens SPP FXD6 Breakers
   e. Or equal

F. Panelboards and distribution panels shall be of same manufacturer. Refer to drawings where higher interrupting are required.
G. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
   3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
      4. Instantaneous trip.
      5. Long- and short-time pickup levels.
      7. Ground-fault pickup level, time delay, and I2t response.
   8. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (5-mA trip).

H. All power panels shall have surge protection. Coordination and Arc flash study shall be submitted with shop drawing submittal. All circuit breaker selection shall meet study recommendations and shall be provided as recommended by study.

I. Electrical Sub-contractor shall provide infrared scanning of all panelboards after three months past substantial completion. Provide report indicating status of all terminations at respective panelboards per phase.

2.13 ELECTRIC SERVICE

A. Coordinate and cooperate with Eversource, hereinafter called utility company, with respect to providing service and metering.

B. Provide all primary system raceways, elbows, pull wires and all pad grounding. Utility company will provide pad mounted transformer and primary conductors including making up of all terminations and connections.

C. Provide secondary service complete including all conductors, raceways, and connectors at transformer. Provide oversize lugs if required due to conductor sizing. Attachment of secondary conductors to the transformer terminals will be done by the electrical contractor.

D. General Trades Contractor will do all excavation and back filling in accordance with utility company standards and will install the pre-cast transformer pad furnished by the E.C.

E. All work to be done in accordance with utility company standards.

F. Metering: All usage will be on one secondary meter. Utility Company will furnish current transformers and potential transformers to be installed in C.T. cabinet. Provide meter socket per utility company standards. Meter will be by the Utility Co. Metering will be cold Sequence per utility co. E.C. shall provide Main breaker ahead of C.T. cabinet.
2.14 FIRE ALARM AND DETECTION SYSTEM

A. Description:

1. This section of the specification includes the furnishing, installation, connection and testing of the microprocessor controlled, intelligent reporting fire alarm network equipment required to form a complete, operative, coordinated system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, Network Fire Alarm Control Panel (FACP), auxiliary control devices, annunciators, and wiring as shown on the drawings and specified herein.

2. The fire alarm system shall comply with requirements of latest NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.

3. The fire alarm manufacturer shall be of the highest caliber and insist on the highest quality. The system shall be manufactured by an ISO 9001 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994.

4. The FACP and peripheral devices shall be manufactured 100 percent by a single U.S. manufacturer (or division thereof).

5. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and shall be in compliance with the UL listing.

6. The installing company shall employ NICET (minimum Level II Fire Alarm Telecommunications) technicians on site to guide the final check-out and to ensure the systems integrity.

B. Scope:

1. A new network intelligent reporting, microprocessor controlled fire detection and alarm system shall be installed in accordance with the specifications and drawings.

2. Basic Performance:
   a. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded onto NFPA Style 7 (Class A) Signaling Line Circuits (SLC).
   b. Initiation Device Circuits (IDC) shall be wired Class A (NFPA Style D).
   c. Notification Appliance Circuits (NAC) shall be wired Class A (NFPA Style Z).
   d. Digitized electronic signals shall employ check digits or multiple polling.
   e. Power for initiating devices and notification appliances must be from the main fire alarm control panel.
   f. A single ground or open on any system signaling line circuit, initiating device circuit, or notification appliance circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
   g. Alarm signals arriving at the main FACP shall not be lost following a power failure (or outage) until the alarm signal is processed and recorded.

3. Basic System Functional Operation:

4. When a fire alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
   a. The FACP alarm LED on the FACP shall flash.
   b. A local piezo-electric signal in the FACP control panel shall sound.
   c. The 80-character LCD display on the local FACP node and on the intelligent network display shall indicate all information associated with the fire alarm condition, including the type of alarm point, and its location within the protected premises. This information shall also be displayed on the network reporting terminal.
5. Software Modifications:
   a. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.
   b. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm network on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.

6. Certifications:
   a. Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer and trained on network applications. Include names and addresses in the certification.
   b. Power supplies, relays, water flow switches and all accessories of the fire alarm system.
   c. Each circuit in the fire alarm network shall be tested semiannually.
   d. Each smoke detector shall be tested in accordance with the requirements of NFPA 72, Chapter 7.

C. Applicable Publications:

   The publications listed below form a part of this specification. The publications are referenced in text by the basic designation only.

1. National Fire Protection Association (NFPA) - USA:
   a. No. 72 National Fire Alarm Code
   b. No. 70 National Electric Code
   c. No. 101 Life Safety Code

2. Underwriters Laboratories Inc. (UL) - USA:
   a. No. 50 Cabinets and Boxes
   b. No. 268 Smoke Detectors for Fire Protective Signaling Systems
   c. No. 864 Control Units for Fire Protective Signaling Systems
   d. No. 268A Smoke Detectors for Duct Applications
No. 521  Heat Detectors for Fire Protective Signaling Systems
No. 228  Door Closers-Holders for Fire Protective Signaling Systems
No. 464  Audible Signaling Appliances
No. 38   Manually Actuated Signaling Boxes
No. 346  Waterflow Indicators for Fire Protective Signaling Systems
No. 1481 Power supplies for Fire Protective Signaling Systems
No. 1076 Control Units for Burglar Alarm Proprietary Protective Signaling Systems
No. 1971 Visual Notification Appliances

3. Local and State Building Codes.
4. All requirements of the Authority Having Jurisdiction (AHJ).

D. Approvals:

1. The system must have proper listing and/or approval from the following nationally recognized agencies:
   UL   Underwriters Laboratories Inc.
   FM   Factory Mutual
   MEA  Material Equipment Acceptance (NYC)
   CSFM California State Fire Marshal

2. The fire alarm control panel shall meet the modular labeling requirements of Underwriters Laboratories, Inc. Each subassembly, including all printed circuits, shall include the appropriate UL modular label. Systems which do not include modular labels which may require return to the manufacturer for system upgrades, and are not acceptable.

E. Equipment and Material, General:

1. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling (fire alarm) system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.

2. All equipment and components shall be installed in strict compliance with each manufacturer's recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc. before beginning system installation. Refer to the riser/connection diagram for all specific system installation/termination/wiring data.

3. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place. (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.
F. Conduit and Wire:

1. Conduit:
   
   a. Conduit shall be in accordance with the National Electrical Code (NEC), local and state requirements.
   
   b. All wiring exposed shall be installed in conduit. All wiring exposed in finish spaces shall be in surface metal raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
   
   c. Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760-29.
   
   d. Wiring for 24 volt control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
   
   e. Conduit shall not enter any FACP, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.
   
   f. Conduit shall be 3/4 inch (19.1 mm) minimum.

2. Wire:

   a. All fire alarm system wiring must be new, unless specified herein.
   
   b. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 16 AWG (1.02 mm) for initiating device circuits and signaling line circuits, and 14 AWG (1.32 mm) for notification appliance circuits.
   
   c. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
   
   d. Wiring used for the SLC multiplex communication loop shall be twisted and shielded unless specifically excepted by the fire alarm equipment manufacturer.
   
   e. All field wiring shall be completely supervised.
   
   f. MC cable with red armor may be used where concealed and allowed by code.

3. Terminal Boxes, Junction Boxes and Cabinets:

4. All boxes and cabinets shall be UL listed for the intended purpose.

5. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterlow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.

6. The FACP shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the main power distribution Panel as FIRE ALARM. Fire alarm control panel primary power wiring shall be 12 AWG. The FACP cabinet shall be grounded securely to either a cold water pipe or grounding rod. Provide lock-on device on breaker.
G. Fire Alarm Control Panel:

1. Fire alarm control panel shall be Notifier NFS3030, Edwards EST3, FCI-E3, or equal. The FACP shall contain a microprocessor based central processing unit (CPU). The FACP shall communicate with and control the following types of equipment used to make up the system: intelligent detectors, addressable modules, local and remote operator terminals, annunciators, and other system controlled devices.

2. Node Capacity and General Operation:

   a. Each node shall provide, or be capable of, expansion to 198 intelligent addressable devices and 198 monitor/control modules for a total of 396 intelligent devices per system. FACP shall have 2 intelligent loops.
   b. Each FACP node shall include a full featured operator interface control and annunciation panel which shall include a backlit Liquid Crystal Display (LCD), individual, color coded system status LEDs, and an alpha-numeric keypad for field programming and control of the node.
   c. All programming or editing of the existing programming the system shall be achieved without special equipment or interrupting the alarm monitoring functions of the fire alarm control panel.
   d. Each FACP node shall provide the following features:
      - Block Acknowledge
      - Printer Interface
      - Control-by-Time
      - Non-Alarm Module
      - Reporting
      - Day/Night Sensitivity
      - Periodic Detector Test
      - Device Blink Control
      - Remote Page
      - Drift Compensation
      - Trouble Reminder
      - NFPA 72, Sensitivity
      - Upload/Download to PC
      - Test computer
      - System Status Reports
      - Verification Counters
      - Security Monitor Points
      - Walk Test
      - Alarm Verification
      - Maintenance Alert

3. Loop Interface Board (LIB):

   a. Loop interface boards shall be provided to monitor and control each of the Signaling Line Circuit (SLC) loops in the network node. The loop interface board shall contain its own microprocessor and shall be capable of operating in local mode in the case of a failure in the main CPU of the control panel. In local mode, the loop interface board shall detect alarms and activate output devices on its own SLC loop.
   b. The LIB shall not require any jumper cuts or address switch settings to initialize SLC Loop operations.
   c. The loop interface board shall provide power to, and communicate with, all of the intelligent detectors and addressable modules connected to its SLC Loop over a single pair of wires. This SLC Loop shall be capable of operation as NFPA Style 4, Style 6, or Style 7.
   d. The LIB shall be able to drive two Style 4 SLC loops, each up to 10,000 feet in length, for an effective loop span of 20,000 feet.
e. The loop interface board shall receive analog information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular detector. The loop interface board software shall include software to automatically adjust and compensate for dust accumulation to maintain detector performance as it is affected by environmental factors. The analog information may also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.

f. The LIB shall communicate with each intelligent addressable detector and addressable module on its SLC loop and verify proper device function and status. Communication with up to 198 intelligent devices shall be performed every 6 seconds or less.

4. Enclosures:

a. Control panels shall be housed in UL listed cabinets suitable for surface or semi-flush mounting. Cabinets shall be corrosion protected, given a rust-resistant prime coat, and the manufacturer's standard finish.

b. The back box and door shall be constructed of .060 steel with provisions for electrical conduit connections into the sides and top.

c. The door shall provide a key lock and include a transparent opening for viewing all indicators. For convenience, the door shall have the ability to be hinged on either the right or left-hand side.

d. The control unit shall be modular in structure for ease of installation, maintenance, and future expansion.

5. FACP nodes shall be designed so that it permits continued local operation of remote transponders under both normal and abnormal network communication loop conditions. This shall be obtained by having transponders operate as local control panels upon loss of network communication.

6. FACP nodes shall be modular in construction to allow ease of servicing. Each CPU and transponder shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems which require use of external programmers or change of EPROM's are not acceptable.

7. The CPU and associated equipment are to be protected so that they will not be affected by voltage surges or line transients including RFI and EMI.

8. Each peripheral device connected to the FACP node CPU shall be continuously scanned for proper operation. Data transmissions between network nodes, FACP CPUs, transponders, and peripheral devices shall be reliable and error free. The transmission scheme used shall employ dual transmission or other equivalent error checking techniques. Failure of any transponder or peripheral device to respond to an interrogation shall be annunciated as a trouble condition.

9. FACP Power Supplies:

a. Main power supplies shall operate on 120 VAC, 60Hz, and shall provide all necessary power for the FACP.

b. Each main supply shall provide 3.0 amps of usable notification appliance power, using a switching 24 VDC regulator.

c. The main power supply shall be expandable for additional notification appliance power in 3.0 ampere steps. Provide dedicated power supplies for signal circuit.

d. Each main power supply shall provide a battery charger for 60 hours of standby using dual-rate charging techniques for fast battery recharge. It shall charge 55 Amp hour batteries within a 48 hour period.

e. The supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults on sensitive addressable modules.

f. It shall provide meters to indicate battery voltage and charging current.
g. The main power supply shall be power-limited per 1995 UL864 requirements.

10. System Circuit Supervision:
   a. Each FACP node shall supervise all circuits to intelligent devices, transponders, annunciators and peripheral equipment and annunciate loss of communications with these devices. The FACP CPU shall continuously scan the above devices for proper system operation and upon loss of response from a device shall sound an audible trouble, indicate which device or devices are not responding and print the information on the printer.
   b. Sprinkler system valves, standpipe control valves, PIV, and main gate valves shall be supervised for off-normal position.

11. Field Wiring Terminal Blocks:
   a. For ease of service, all wiring terminal blocks shall be the plug-in type and have sufficient capacity for 18 to 12 AWG wire. Fixed terminal blocks are not acceptable.

12. Field Programming:
   a. The system shall be programmable, configurable and expandable in the field without the need for special tools or electronic equipment and shall not require field replacement of electronic integrated circuits.
   b. All local FACP node programming shall be accomplished through the FACP keyboard.
   c. All field-defined programs shall be stored in non-volatile memory.
   d. The programming function shall be enabled with a password that may be defined specifically for the system when it is installed. Two levels of password protection shall be provided in addition to a key-lock cabinet. One level is used for status level changes such as zone disable or manual on/off commands. A second (higher-level) is used for actual change of program information.

13. Specific System Operations:
   a. Smoke Detector Sensitivity Adjust: Means shall be provided for adjusting the sensitivity of any or all analog intelligent detectors in the FACP node from each system keypad or from the keyboard of the video terminal. Sensitivity range shall be within allowed UL limits.
   b. Alarm Verification: Each of the intelligent addressable detectors in the system may be independently selected and enabled for alarm verification. Each FACP shall keep a count of the number of times each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.
   c. System Point Operations:
      1) All devices in the FACP node may be enabled or disabled through the local keypad or video terminal.
      2) Any FACP node output point may be turned on or off from the local system keypad or the video terminal.
d. Point Read: The FACP node shall be able to display the following point status diagnostic functions without the need for peripheral equipment. Each point will be annunciated for the parameters listed:

1) Device Status
2) Device Type
3) Custom Device Label
4) Software Zone Label
5) Device Zone Assignments
6) Detector Analog Value
7) All Program Parameters

e. System Status Reports: Upon command from a password-authorized operator of the system, a status report will be generated, and printed, listing all local FACP system status.

f. System History Recording and Reporting: Each FACP node shall contain a history buffer that shall be capable of storing a minimum of 400 system events. Each local activation will be stored and time and date stamped with the actual time of the activation, until an operator requests that the contents be either displayed or printed. The contents of the history buffer may be manually reviewed, one event at a time, and the actual number of activations may also be displayed and or printed.

g. The history buffer shall use non-volatile memory. Systems which use volatile memory for history storage are not acceptable.

h. Automatic Detector Maintenance Alert: Each FACP node shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time.

i. If any intelligent detector in the system responds with a reading that is below or above normal limits, then the system will enter the trouble mode, and the particular intelligent detector will be annunciated on the system display, network display and printed on the optional system printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.

H. Addressable Devices – General:

1. Addressable devices shall use simple to install and maintain decade (numbered 1 to 10) type address switches.
2. Addressable devices which use a binary address setting method, such as a Dip switch, are difficult to install and subject to installation error. This type of device is not an allowable substitute.
3. Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the FACP signaling line circuit.
4. Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.
5. Smoke detector sensitivity shall be set in the fire alarm control panel and shall be adjustable in the field through the field programming of the system. Sensitivity may be automatically adjusted by the panel on a time-of-day basis.
6. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.

7. The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Class A applications.

8. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.

9. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).

10. Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.

11. A magnetic test switch shall be provided to test each detector for 100 percent obscuration, reported to the FACP.

12. Addressable devices shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. LED(s) shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.

13. A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100 percent of the alarm threshold.

I. Addressable Pull Box (manual station):

1. Addressable pull boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.

2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.

3. Manual stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches or larger.

4. Stations shall be suitable for surface mounting or semiflush mounting as shown on the plans, and shall be installed not less than 42 inches, nor more than 48 inches above the finished floor.

5. Manual pull stations shall be of the double action type.

J. Intelligent Photoelectric Smoke Detector:

1. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
K. Intelligent Thermal Detectors:
   1. Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit. Up to 99 intelligent heat detectors may connect to one SLC loop.

L. Intelligent Duct Smoke Detector:
   1. The in-duct smoke detector housing shall accommodate either an intelligent ionization detector or an intelligent photoelectric detector, of that provides continuous analog monitoring and alarm verification from the panel.
   2. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.

M. Duct mounted carbon monoxide detector:
   1. Manufactured by Air Products and Controls Model SL-701 or Equal
   2. Product Specifications:

   Voltages available: 230VAC, 115VAC, 24VAC, 24VDC

   APPROVALS
   Electrochemical Carbon Monoxide Sensor is a UL Recognized component in accordance with the requirements of UL2034. Also meets EN50291 requirements. SL-2000 Series Duct Smoke Detector Fire Alarm Certifications referenced side one:
   UL & CUL Listed (UL268A, UROX, UROX7) File # S2829 CSFM Listed (3240-1004:105); MEA Accepted (73-92-E, VOL. 27)

   SAMPLING TUBES Provide required length for duct coordinate with HVAC drawings
   Sectional sampling tube
   Metal sampling tube for 6” to 2.5’ duct width
   Metal sampling tube for 2.5’ to 5.0’ duct width
   Metal sampling tube for 5.0’ to 10.0’ duct width

   ACCESORIES
   MSR-50/CO remote accessory
   TG-701 aerosol test gas
   T-PB power supplies
   WP-2000 weatherproof enclosure
   (All available from Air Products and Controls Inc.)

   POWER REQUIREMENTS
   Input Power | Standby Current | Alarm Current
   24VAC | 55mA | 190mA
   24VDC | 14mA | 68mA
   115VAC | 22mA | 32mA
   230VAC | 12mA | 18mA

   RELAY CONTACT RATING:
   Alarm Contacts
   Resistive load: 2 sets form “C” rated at 10 Amps @ 115VAC
   Resistive load: 1 set form “A” rated at 2 Amps
   Trouble Contacts
   Resistive load: 1 set form “C” rated at 10 Amps @ 115VAC
AIR VELOCITY: 100 to 4,000 ft./min.
AMBIENT TEMPERATURE: 32°F to 158°F (0°C to 70°C)
HUMIDITY: 10% to 85% RH Non-Condensing / Non-Freezing
WIRING: Solid or stranded: #12 to #22 AWG terminals
MATERIAL: Grey plastic back box, clear plastic cover (Makrolon 94V-0)
DIMENSIONS: 13 ½” L x 4 ½” W x 2 ¼” D
MAX. NET WT.: 2 ½ lbs.
HARDWARE: 7” exhaust tube, FAST Tube starter sampling tube, sampling tube end cap, mounting template, and mounting hardware included.

**N. Addressable Dry Contact Monitor Module:**

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLC loops.
2. The monitor module shall mount in a 4-inch square, 2-1/8 inch deep electrical box.
3. The IDC zone may be wired for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
4. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch x 1-1/4 inch x 1/2 inch. This version need not include Style D or an LED.

**O. Two-Wire Detector Monitor Module:**

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional 2-wire smoke detectors or alarm initiating devices (any N.O. dry contact device).
2. The two-wire monitor module shall mount in a 4-inch square, 2-1/8 inch deep electrical box or with an optional surface backbox.
3. The IDC zone may be wired for Class A or B (Style D or Style B) operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

**P. Addressable Control Module:**

1. Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contact relay.
2. The control module shall mount in a standard 4-inch square, 2-1/8 inch deep electrical box, or to a surface mounted backbox.
3. The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation, or as a dry contact (Form-C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100 percent of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.
4. Audio/visual power shall be provided by a separate supervised power loop from the main fire alarm control panel or from a supervised, UL listed remote power supply.
5. The control module shall be suitable for pilot duty applications and rated for a minimum of .6 amps at 30 VDC.
Q. Isolator Module:

1. Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC loop. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC Loop. At least one isolator module shall be provided for each floor or protected zone of the building.

2. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC loop. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.

3. The isolator module shall not require any address setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.

4. The isolator module shall mount in a standard 4-inch deep electrical box or in a surface mounted backbox. It shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

R. LCD Alphanumeric Display Annunciator:

1. The alphanumeric display annunciator shall be a supervised, backlit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English text.

2. The LCD annunciator shall display all alarm and trouble conditions from either the network node or complete network, via the INA.

3. Up to 32 LCD annunciators may be connected to a specific (terminal mode) EIA 485 interface. LCD annunciators shall not reduce the annunciation capacity of the system. Each LCD annunciator shall include vital system wide functions such as, system acknowledge, silence and reset.

4. LCD display annunciators shall mimic the local control panel 80 character display or network annunciator and shall not require special programming.

5. The LCD annunciator shall have the same vital functions as the fire alarm control panel.

S. Batteries and External Charger:

1. Battery:
   a. Batteries shall be 12 volt, Gell-Cell type.
   b. The battery shall have sufficient capacity to power the fire alarm system for not less than 60 hours plus 15 minutes of alarm upon a normal AC power failure.
   c. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills and leakage shall not be required.

T. Audio/Visual Unit (Xenon Strobe):

1. Combination horn strobe units - Provide Truealert Non-Addressable 75 Cd, Red Sync. Two Wire. Comprised of a 24 VDC Xenon Flash Tube entirely solid state. The unit shall require a sync. Control module. Provide True 75 Cd from all axis.


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U. Magnetic Door Holders:

1. Provide Semi-Flush or Flush Wall Mounted, 24 V.D.C. with catch plate.

V. Provide clear plastic covers with local audible alarm for pull stations in cell block area, where indicated on drawings, and required by fire department.

W. Alarm Transmission:

1. FACP to include “UDACT” communicator with Contract ID to report by device.

X. Testing:

1. 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.

2. 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:

   a. Factory trained and certified.
   b. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified.
   c. International Municipal Signal Association (IMSA) fire alarm certified.
   d. Trained and qualified personnel employed by an organization listed by a national testing laboratory for the servicing of fire alarm systems.

3. 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.

4. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing.

5. Minimum System Tests: Test the system according to the procedures outlined in NFPA 72.

6. 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.


8. Final Test, Certificate of Completion, and Certificate of Occupancy:

   a. Test the entire system new 100 percent devices as required by the Authority Having Jurisdiction in order to obtain a certificate of occupancy.


   a. Provide a one-year inspection and testing agreement in accordance with local Fire Department requirements and NFPA 72 recommendations. The holder of the testing and maintenance contract shall be a properly licensed and NRTL certified provider of Fire Alarm services and acceptable to the Fire Department.
b. Fire alarm testing agreement shall provide for a minimum of four inspections per year. Upon completion of each test, list actual devices checked. Provide a report to the Owner.

Y. Training:
1. Provide two (2) 4-hour sessions of Owner training with Owner’s Representative.

2.15 SURGE PROTECTION DEVICES

A. SCOPE
1. This section describes the materials and installation requirements for surge protective devices (SPD) for the protection of all main service and panelboards.

B. SUBMITTALS
1. Submit shop drawings and product information for approval and final documentation in the quantities listed according to the Conditions of the Contract. All transmittals shall be identified by customer name, customer location, and customer order number.
2. Submittals shall include UL 1449 3rd Edition Listing documentation verifiable by visiting www.UL.com, clicking “Certifications” link, searching using UL Category Code: VZCA and VZCA2:
   a. Short Circuit Current Rating (SCCR)
   b. Voltage Protection Ratings (VPRs) for all modes
   c. Maximum Continuous Operating Voltage rating (MCOV)
   d. I-nominal rating (I-n)
   e. SPD shall be UL listed and labeled as Type 1 or Type 4 intended for Type 1 or Type 2 applications
3. Upon request, an unencapsulated but complete SPD formally known as TVSS shall be presented for visual inspection.
4. Minimum of ten (10) year warranty

C. RELATED STANDARDS
1. IEEE C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits,
2. IEEE C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits,
5. UL 1283 - Electromagnetic Interference Filters

D. QUALITY ASSURANCE
1. Manufacturer Qualifications: Engage a firm with at least 5 years’ experience in manufacturing transient voltage surge suppressors.
2. Manufacturer shall be ISO 9001 or 9002 certified.
3. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of ten (10) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

4. The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

E. DELIVERY, STORAGE AND HANDLING

1. Handle and store equipment in accordance with manufacturer’s Installation and Maintenance Manuals. One (1) copy of this document to be provided with the equipment at time of shipment.

F. MANUFACTURERS

1. Provide an internally mounted Surge Protective Devices (SPD) formerly called Transient Voltage Suppressors (TVSS) by:
   a. Siemens Industry.
   b. Current Technology
   c. LEA
   d. Liebert
   e. APT
   f. Or equal

G. ELECTRICAL DISTRIBUTION EQUIPMENT

1. Service Entrance
   a. SPD shall be UL 1449 labeled as Type 1 or Type 4 intended for Type 1 or Type 2 applications, verifiable at UL.com, without need for external or supplemental overcurrent controls. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal overtemperature controls. SPDs relying upon external or supplementary installed safety disconnectors do not meet the intent of this specification.
   b. SPD shall be factory installed integral to electrical distribution equipment.
   c. SPD shall be UL labeled with 20kA I-nominal (I-n)
   d. SPD shall be UL labeled with 200kA Short Circuit Current Rating (SCCR).
   e. Standard 7 Mode Protection paths: SPD shall provide surge current paths for all modes of protection: L-N, L-G, L-L, and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems.
   f. True 10 Mode Protection paths: SPD shall provide “directly connected protection elements” between all possible modes of protection: L-N, L-G, L-L, and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems.
   g. SPD shall be connected external of the distribution equipment with an appropriately sized 200kA SCCR rated disconnect.
   h. SPD shall meet or exceed the following criteria:
      1) Maximum 7-Mode surge current capability shall be 300kA per phase.
      2) Maximum 10-Mode surge current capability shall be 300kA per phase.
      3) UL 1449 - Third Edition Revision; effective September 29, 2009 Voltage Protection Ratings shall not exceed the following:

<table>
<thead>
<tr>
<th>VOLTAGE</th>
<th>L-N</th>
<th>L-G</th>
<th>N-G</th>
<th>L-L</th>
<th>MCOV</th>
</tr>
</thead>
<tbody>
<tr>
<td>208Y/120</td>
<td>800V</td>
<td>800V</td>
<td>800V</td>
<td>1200V</td>
<td>150V</td>
</tr>
</tbody>
</table>

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i. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com):

<table>
<thead>
<tr>
<th>System Voltage</th>
<th>Allowable System Voltage Fluctuation (percent)</th>
<th>MCOV</th>
</tr>
</thead>
<tbody>
<tr>
<td>208Y/120</td>
<td>25 percent</td>
<td>150V</td>
</tr>
</tbody>
</table>

j. SPD shall incorporate a UL 1283 listed EMI/RFI filter with minimum attenuation of -50dB at 100 kHz.

k. Suppression components shall be heavy duty ‘large block’ MOVs, each exceeding 30mm diameter.

l. SPD shall include a serviceable, replaceable module.

m. SPD shall be equipped with the following diagnostics:
   1) Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.
   2) Audible alarm with on/off silence function and diagnostic test function (excluding branch).
   3) Form C dry contacts
   4) Optional – Surge Counter
   5) No other test equipment shall be required for SPD monitoring or testing before or after installation.

n. SPD shall have a response time no greater than 1/2 nanosecond.

o. SPD shall have a 10 year warranty.

2. Distribution Panel

a. SPD shall be UL 1449 labeled as Type 4 intended for Type 1 or Type 2 applications, verifiable at UL.com, without need for external or supplemental overcurrent controls. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal overtemperature controls. SPDs relying upon external or supplementary installed safety disconnectors do not meet the intent of this specification.

b. SPD shall be factory installed integral to electrical distribution equipment.

c. SPD shall be UL labeled with 20kA I-nominal (I-n)

d. SPD shall be UL labeled with 200kA Short Circuit Current Rating (SCCR).

e. Standard 7 Mode Protection paths: SPD shall provide surge current paths for all modes of protection: L-N, L-G, L-L, and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems.

f. SPD shall be connected to the buss of the distribution equipment with an appropriately sized 200kA SCCR rated disconnect.

g. SPD shall meet or exceed the following criteria:
   1) Maximum 7-Mode surge current capability shall be 100kA per phase.
   2) Maximum 10-Mode surge current capability shall be 150kA per phase.
   3) UL 1449 - Third Edition Revision; effective September 29, 2009, Voltage Protection Ratings shall not exceed the following:

<table>
<thead>
<tr>
<th>VOLTAGE</th>
<th>L-N</th>
<th>L-G</th>
<th>N-G</th>
<th>L-L</th>
<th>MCOV</th>
</tr>
</thead>
<tbody>
<tr>
<td>208Y/120</td>
<td>800V</td>
<td>800V</td>
<td>800V</td>
<td>1200V</td>
<td>150V</td>
</tr>
</tbody>
</table>

   a) UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com):

<table>
<thead>
<tr>
<th>System Voltage</th>
<th>Allowable System Voltage Fluctuation (percent)</th>
<th>MCOV</th>
</tr>
</thead>
<tbody>
<tr>
<td>208Y/120</td>
<td>25 percent</td>
<td>150V</td>
</tr>
</tbody>
</table>

h. SPD shall incorporate a UL 1283 listed EMI/RFI filter with minimum attenuation of -50dB at 100 kHz.
Suppression components shall be heavy duty ‘large block’ MOVs, each exceeding 30mm diameter.

SPD shall include a serviceable, replaceable module.

SPD shall be equipped with the following diagnostics:

1) Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.
2) Audible alarm with on/off silence function and diagnostic test function (excluding branch).
3) Form C dry contacts
4) Optional – Surge Counter
5) No other test equipment shall be required for SPD monitoring or testing before or after installation.

SPD shall have a response time no greater than 1/2 nanosecond.

SPD shall have a 10 year warranty.

Branch Panels

The panelboard shall be UL 67 Listed and the SPD shall be UL 1449 labeled as Type 1 or as Type 4 intended for Type 1 or Type 2 applications.

The unit shall be top or bottom feed according to requirements. A circuit directory shall be located inside the door.

SPD shall meet or exceed the following criteria:

1) Maximum 7-Mode surge current capability shall be 100kA per phase.
2) Maximum 10-Mode surge current capability shall be 150kA per phase.
3) UL 1449 - Third Edition Revision; effective September 29, 2009, Voltage Protection Ratings shall not exceed the following:

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System Voltage | Allowable System Voltage Fluctuation (percent) | MCOV |
----------------|---------------------------------------------|------|
208Y/120        | 25 percent                                   | 150V |

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3) Form C dry contacts
4) Optional – Surge Counter
5) No other test equipment shall be required for SPD monitoring or testing before or after installation.

SPD shall have a response time no greater than 1/2 nanosecond.
x. SPD shall have a 10 year warranty.
y. The unit shall have removable interior.
z. The main bus shall be [copper] [aluminum] and rated for the load current required.
   aa. The unit shall include a 200 percent rated neutral assembly with copper neutral bus.
   bb. The unit shall be provided with a safety ground bus.
   cc. The field connections to the panelboard shall be main lug or main breaker.
   dd. The unit shall be constructed with flush or surface mounted trim and shall be in a NEMA Type 1 enclosure.

H. INSTALLATION
   1. Install per manufacturer’s recommendations and contract documents.

I. ADJUSTMENTS AND CLEANING
   1. Remove debris from installation site and wipe dust and dirt from all components.
   2. Repaint marred and scratched surfaces with touch up paint to match original finish.

J. TESTING
   1. Check tightness of all accessible mechanical and electrical connections to assure they are torqued to the minimum acceptable manufacturer’s recommendations.
   2. Check all installed panels for proper grounding, fastening and alignment.

K. WARRANTY
   1. Equipment manufacturer warrants that all goods supplied are free of non-conformities in workmanship and materials for one year from date of initial operation, but not more than eighteen months from date of shipment.

2.16 AUTOMATED LIGHTING CONTROL SYSTEM

A. General: Summary
   1. Section Includes:
      a. Addressable Networked Light Management System.

B. References
   1. National Fire Protection Association (NFPA)
   2. cULus Listing/Certification
      a. Certified as Energy Management Equipment (UL 916)
      b. Certified as Emergency Lighting Equipment (UL 924)
      c. Meet Heat and Smoke Release for Air-Handling Spaces (UL 2043)
   3. Federal Communications Commission (FCC) / Industry Canada (IC)
   4. California Energy Commission (CEC)
   5. Local Building Codes
C. System Description

1. Lighting Control System includes computer-based software that provides control, configuration, monitoring and reports. System including but not limited to the following components:

   a. Central Control Unit
   b. System Server
   c. 0-10V Dimming, Fixed Output Ballasts or 0-10V LED Drivers
   d. System Field Devices (Input and Output Modules)
   e. Lighting Control System Software
   f. Lighting Controllers
   g. Communication Wire
   h. Occupancy sensors
   i. Photo sensors
   j. Wireless site lighting control modules (#WSLC), one per pole mounted fixture
   k. Wireless Manager for site lighting
   l. Wireless Control modules #WCM
   m. Lighting control panels
   n. Interface to audio visual equipment
   o. Interface to BACnet
   p. Interface to Tridium Niagara
   q. Incandescent low-voltage dimming modules
   r. Tunable white light programming
   s. Coordination of final lighting programming
   t. Owner training

D. Submittals

1. Bill of Materials: Complete list of all parts needed to fully install selected system components.
2. Product Data: For each type of product indicated.
3. Shop and Wiring Drawings: Submit shop drawings detailing control system, as supplied, including one-line diagrams, wire counts, coverage patterns, interconnection diagrams showing field-installed wiring and physical dimensions of each item.
4. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
   a. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
   b. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.
5. Software Operational Documentation:
   a. Software operating and upgrade manuals.
   b. Program Software Backup: On compact disc or DVD, complete with data files.
   c. Printout of software application and graphic screens, or upon request, a live demonstration of Control, Configure and Analyze functionality or a video demonstrating above stated system capabilities.
6. Installation Instructions: Manufacturer’s installation instructions.
7. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.
8. Warranty: Copy of applicable warranty.

E. Quality Assurance

1. 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.
2. Manufacturer Requirements: The manufacturer shall have a minimum of 10 years experience manufacturing networked lighting control systems and shall provide 24/7 telephone support by qualified technicians.
3. Contractor shall ensure that lighting system control devices and assemblies are fully compatible and can be integrated into a system that operates as described in the lighting control notes on drawings and as described within this specification. Any incompatibilities between devices, assemblies, and system controllers shall be resolved between the contractor and the system provider to ensure proper system operation and maintainability.
4. Performance Requirements: provide all system components that have been manufactured, assembled, and installed to maintain performance criteria stated by manufacturer without defects, damage, or failure.
5. Performance Testing Requirements
   a. Manufacturer shall 100 percent test all equipment prior to shipment. Sample testing is not acceptable.

6. Code Requirements

   a. System Control Unit and System Field Devices shall be cULus listed and certified.
   b. All system components shall be FCC /IC compliant.
   c. All system components shall be installed in compliance with National Electrical Codes and Canadian Electrical Code.
   d. Building Codes: All units shall be installed in compliance with applicable, local building codes.

7. ISO Certification: System components shall be manufactured at ISO-9000 certified plants.

F. COORDINATION

1. Coordinate lighting control components to form an integrated interconnection of compatible components.
   a. Match components and interconnections for optimum performance of lighting control functions.
   b. Display graphics showing building areas controlled; include the status of lighting controls in each area.

G. Delivery, Storage & Handling

1. Ordering: Comply with manufacturer’s ordering instructions and lead-time requirements to avoid construction delays.
2. Delivery: Deliver materials in manufacturer’s original, unopened, undamaged packaging with intact identification labels.
3. Storage and Protection: Store materials away from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

H. Warranty

1. On-going system expansion, service and support shall be available from multiple factory certified vendors. Recommended service agreements shall be submitted at the time of bid complete with manufacturers suggested inventory and pricing for system parts and technical support labor.

2. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship within specified warranty period.

3. Manufacturer’s Warranty: All equipment shall be warranted free of defects in materials and workmanship.

   a. Warranty Period: All system hardware components shall have full warranty (non-prorated) for at least four years and all software components shall carry a warranty of 90 days from date of installation.

   b. Owner Rights: Manufacturer’s warranty is in addition to, not a limitation of, other rights the Owner may have under contract documents, or warranties of third party component manufacturers.

I. Basis of Design Products

1. Controls: ENCELUM Energy Management System by OSRAM SYLVANIA


J. Acceptable Alternate Manufacturers

1. Controls: Lutron, N-light, Philips, or equal.

2. Sensors: Lutron, Sensor Switch, Watt Stopper, Leviton, Cooper or equal.

K. System Performance Requirements

1. This specification is intended to fully describe all of the design, engineering, programming, hardware, software, ancillary devices and associated technical services required to provide a building-wide networked lighting control system. This system is specified to perform scheduled and automated lighting control sequences.

2. The lighting control “system” shall include a fully distributed WAN/LAN network of global controller/routers, individually addressable System Field Devices, sensors, switches, relays and other ancillary devices required for a complete and operable system. The system WAN/LAN shall be commissioned by ENCELUM personnel or other ENCELUM certified commissioning contractors.

3. The basis of system design shall utilize non-proprietary industry standard 0-10V dimming or fixed output ballasts and/or 0-10V LED drivers, occupancy sensors, and daylight sensors.

4. On-going system expansion, service and support shall be available from multiple factory certified vendors. Recommended service agreements may be submitted at the time of bid complete with manufacturers suggested inventory and pricing for system parts and technical support labor.
5. Lighting Control Software: The system shall offer two separate levels of lighting control: one personal lighting control for the average building occupant to control and adjust basic lighting functions in their workspace, and two central lighting control for the facility lighting administrator to perform energy management, configuration maintenance, monitoring operations, and providing support to building occupants.

   a. Native central control software shall be utilized for energy reporting status and complete programming without the need for any third party hardware or software. Systems that require any third party linked software or graphics shall be unacceptable.

   b. Software shall provide information on general system settings via mouse click on a floor plan. Left clicking over a device on the graphical software interface shall show a description of the selected device/function attribute.

6. Central Lighting Control:

   a. Shall provide an Interactive, Web-based graphical user interface (GUI) showing floor plans and lighting layouts that are native to the lighting control software. The only means required to program and operate the lighting control system shall be programmed and operated from a user interface that is based on a plan view graphical screen on the user’s computer or the lighting control system’s main computer. Shall include the navigational features listed below to allow for user’s orientation within the controlled space, geographic heading and/or landmarks:

      1) Interactive
      2) Vector based
      3) Zoom
      4) Rotate
      5) Pan
      6) Tilt

   b. Shall allow building operator to navigate through an entire facility both in two-dimensional and three-dimensional multi-floor view, allowing for fast and easy navigation.

   c. Three-dimensional view shall exclude walls and other structural features to avoid shadowing and cluttering of the plan view.

   d. All programming, assignments of lighting loads to control strategies, lighting status and lighting energy reporting shall be native to the software and executed from this GUI. Editing shall be available from this GUI in a drag and drop format or from drop down menus without the need for any third party software. Systems that utilize or require third party linked graphics are unacceptable. The GUI shall continuously indicate the status of each connected device on the system and a warning indicator on the software if a device goes offline. Systems requiring spreadsheet editing for programming and that don’t offer real time feedback are not acceptable.

   e. Software settings and properties shall be selectable per individual device, room based, floor based or global building based.

      1) Lighting Control Software interface shall provide current status and enable configuration of all system zones including selected individual fixture availability, current light level, maximum light level, on/off status, occupancy status, and emergency mode (response to an emergency signal) status.
f. Shall have the ability to display various lighting system parameters such as Lighting status (ON/OFF); Lighting levels, Load shedding status, or Lighting energy consumption, Occupancy status in a colorized gradient (“weather” map) type of graphical representation.

7. Energy Analysis data shall be exportable in a CSV or similar format.

h. Shall allow import of native AutoCAD files.

7. Reports: Reporting feature shall be native to the lighting control software and capable of reporting the following parameters for each device and zone individually without requiring any third party hardware and software:

a. Energy consumption broken down by energy management strategy.

b. Energy demand broken down by energy management strategy.

c. Occupancy data by zone.

d. Building wide occupancy status.

e. Lighting energy consumption in a color gradient (“weather map” type) view.

f. Energy performance reports shall be printable in a printer friendly format and downloadable for use in spreadsheet applications.

8. Personal Lighting Controls: The Personal Control Software interface shall provide current status and enable each user with the ability to dim and brighten lights, and turn them on and off by individual fixture or zone. The Software shall offer user configurable light scenes, which may be programmed and then selected via the Software. Personal lighting control shall be available in open/private office environments.

9. Daylight Harvesting (Light Regulation Averaging): In a photo sensor-equipped system, the Central Controller Unit shall rationalize changes to light levels when ambient (natural) light is available and shall maintain a steady light level when subjected to fluctuating ambient conditions where dimming ballasts and/or drivers exist. Areas equipped with fixed output ballasts and/or drivers shall energize when natural light falls below foot-candle levels specified. System shall utilize light level inputs from common and/or remote sensor locations to minimize the number of photo sensors required. The System shall operate with multiple users in harmony and not react adversely to manual override inputs.

10. Time Clock Scheduling: The system shall be programmable for scheduling lights on or off via the Lighting Control Software interface.

a. Support for BACnet Time Schedule Object: This allows the export of Lighting Control time schedules to BACnet devices and vice versa in the event of Lighting Control System’s integration with BACnet.

b. Override: Manual adjustments via lighting controllers or personal control software shall temporarily override off status imposed by time clock schedule.

c. Response to Power Failure: In the event of a power failure, the time clock shall execute schedules that would still be in progress had they begun during the power outage.

d. Flick Warning: Prior to a scheduled lights-off event or expiry of a temporary override, the system shall provide two short light level drops as a warning to the affected occupants. Flick warning time shall have the ability to be programmed via software between one and five minutes.
11. Load Shed Mode: An automatic load shedding mode shall be available where, when activated through the system, the control unit will reduce its output to a programmable maximum electrical demand load. The system shall not shed more load than required and load shedding priority shall be centrally configurable by control zone or by common uses (i.e., all hallways can be treated as one load shed group), with subsequent load shed priority groupings being utilized until the required defined load has been shed, for either a defined period, or until the demand response input has been removed. Systems that simply select a “load shed scene” whereby there is no guarantee that the defined required load will actually be shed are not acceptable.

12. Emergency Mode: There shall be a mode, when activated through the system, that will immediately adjust lights to full light output and retain that level until the mode is deactivated in the event of an emergency. This setting shall override all other inputs. The system shall interface with the building of life safety transfer switch, fire alarm control panel, and security system control panel.

13. Addressing: All ballasts and/or drivers shall be centrally addressable, on a per fixture or multiple fixtures/zone basis, through the Central Control Software. The basis of design shall utilize industry standard 0-10V Dimming, Fixed Output Ballasts and/or 0-10V LED Drivers connected to an Output Module. To simplify ongoing maintenance, the system shall not require manual recording of addresses for the purpose of commissioning or reconfiguration.

14. Programmable Task Tuning: Maximum light level programmability shall be available by individual fixture.

15. Unoccupied State: The system shall provide two states when occupancy status is vacant as per an occupancy sensor: lights turn off or lights adjust to configurable (dimmed) light level.

16. Occupied State: The system shall be capable of creating “comfort” or “support” zones to ensure that occupants are not isolated by turning off lights in adjacent areas for occupant comfort and safety, such as a hallway path to exit the premises.

17. The Automated Lighting Control System (ALCS) BACnet Interface shall share the following information with the BACnet enabled Building Automation System and other systems listed below:

<table>
<thead>
<tr>
<th>Property</th>
<th>BACnet Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighting Load</td>
<td>Analog Value*</td>
<td>Reports the total lighting load of the ALS, defined in Watts</td>
</tr>
<tr>
<td>Light Zone State</td>
<td>Binary Value*</td>
<td>State of the defined lighting zone - ON or OFF</td>
</tr>
<tr>
<td>Light Zone Dimming</td>
<td>Analog Value*</td>
<td>Light output level of the defined lighting zone, from 100 percent (maximum light output) to 0 percent (minimum light output)</td>
</tr>
<tr>
<td>Emergency System State</td>
<td>Binary Input</td>
<td>State of the emergency alarm system: alarm activated or alarm not activated</td>
</tr>
<tr>
<td>Fire Alarm State</td>
<td>Binary Input</td>
<td>State of the fire alarm system: alarm activated or alarm not activated</td>
</tr>
</tbody>
</table>
Security System State  Binary Input  State of security alarm system: alarm activated or alarm not activated

Occupancy State  Binary Output  State of the defined occupancy sensor – occupancy detected or not detected

Sheddable Load  Analog Output  Reports the total lighting load available for load reduction according to ALS, defined in Watts

Shed Status  Analog Output  Reports the total current load reduction achieved according to ALS defined prioritization, defined in Watts

Shed Request  Analog Input  Requested total amount of load reduction, defined in Watts or as a percentage of sheddable load

Sheddable Load (Group)  Analog Output  (As above, unprioritized for the selected group)

Shed Status (Group)  Analog Output  (As above, unprioritized for the selected group)

Shed Request (Group)  Analog Input  (As above, unprioritized for the selected group)

18. LAN Operations: System shall be capable of operating independent of building’s existing network infrastructure if desired and shall not rely on tenant supplied PCs for operation. Network infrastructure shall only be utilized for Personal Control Software.

19. Firewall Security: Firewall technology shall be utilized to separate tenants from the lighting control network.

20. Lamp Burn In: The system software shall not permit dimming of new lamps prior to completion of lamp manufacturer 100 hour recommended accumulated operation at full brightness.

21. Re-configurability: The assignment of individual fixtures to zones shall be centrally configurable by Central Control Software such that physical rewiring will not be necessary when workspace reconfiguration or re-zoning is performed. Removal of covers, faceplates, and ceiling tiles shall not be required.

22. Automatic Control Parameters: Occupancy sensor time delays shall be configurable through software. Light level sensor parameters shall be configurable through software.

23. Automatic Time Adjustment: System shall automatically adjust for leap year and daylight savings time and shall provide weekly routine and annual holiday scheduling.

24. Contact closure input: System shall be capable of receiving a momentary and sustained contact closure input from third party sources to control lighting zones.
25. The light management system shall interface digitally with the building automation system via BACnet/IP and Tridium Niagara AX interface. The lighting control system shall communicate the status of output devices (lighting loads) as well as input devices (dry contacts, switches, occupancy sensors, vacancy sensors, and photocells) over this connection allowing the building automation system to utilize lighting control system input devices such as occupancy sensors to determine if mechanical control zones are occupied for climate adjustments.

26. The system software shall provide a web based energy dashboard to show real time energy savings data and carbon footprint reductions.

27. Migration Plan to Control LED Fixtures

   a. System shall be capable of migrating from the control of 0-10V Ballasts to 0-10V LED Drivers utilizing the same Output Modules without the need to change control hardware.

L. Lighting Controllers

1. Description: The system shall include separate lighting controllers for each of the listed functionalities and at minimum meet listed electromagnetic, mechanical, electrical and data specifications:

   a. Software configurable lighting controller that provides on/off switching and dimming control for up to three lighting zones.scenes per controller or more with allowable multi-gang configurations. Status is indicated by an LED display to indicate function, scene or zone. Allows manual override of the time schedule.
   b. Manual dimming and/or switching lighting controller that provides local on/off and dimming control over at least three lighting zones. Allows manual dimming of light levels and override of the time schedule.
   c. Scenes in the central control software shall be synchronized with the buttons on the lighting controller.
   d. Lighting controllers shall fit in a standard Decorator style wall plate and may be ganged together.

2. General

   a. Addressing: All controllers shall be individually addressable & reconfigurable via Central Control Software.
   b. Shall provide local on/off or dimming control over lighting zones
   c. Shall utilizing a standard single-gang or multi-gang form factor
   d. Shall have a terminal block that connects to lighting system with 18 AWG, polarity independent, CMP rated and low voltage wire
   e. Shall be manufactured with push-in wire receptacles
   f. LED’s: All controllers shall feature LED’s to indicate light on and light off status.
   g. Color: All controllers shall meet NEMA WD1 color specifications.
   h. Style: All controllers shall feature Decorator styling wall plates.
   i. Lighting scenes reconfigure automatically based on scene changes from personal control software.
   j. Industrial lighting controllers shall also be available for damp location applications.
   k. Shall comply or exceed the following electromagnetic requirements:

1) EN 61000-4-2
2) EN 61000-4-4
3) EN 61000-4-5
4) FCC Part 15/ICES-003
3. Mechanical Specifications:
   b. Maximum Operating Ambient Temperature: 60 deg C.
   c. Mounts in standard size wall box suitable for multi gang installation or alternative of Low Voltage mounting bracket.
   d. Suitable for use with Decorator style wall plates.

4. Electrical Specifications:
   a. Class 2 Low Voltage device.
   b. Power through interconnected 18 AWG cable with 2-pin header

5. Data Specifications:
   a. Class 2 communication bus that uses prefabricated 18 AWG cable.

M. Wireless Site Lighting Control Module

1. The wireless site lighting control module shall extend the networked light management system's controls capability to a building's surroundings or site such as parking lots and short pathways, via a wireless mesh network based on Zigbee standards. The wireless site lighting control installs on top of a luminaire via an ANSI C136.41 compliance 7-pin twist-lock connector.

2. The wireless site lighting control shall be individually addressable via the wireless system management and can switch luminaires ON/OFF via an integrated high current relay, dim luminaires equipped with 0-10V dimming drivers or ballasts and has an input for an external occupancy sensor.

3. Specifications:
   a. Power:
      1) Operating voltage 120V-347V
      2) Power consumption as no load: <1.0W
      3) Surge protection: 6kV, 6kA
   b. Load Rating: 10A: Electronic driver/ballast, magnetic ballast, resistive load
   c. Interface:
      1) Single dimming output that is 0-10V (IEC 60929 Annex E), DA-LI or DEXAL compatible.
      2) Sink/source 10 mA
      3) Sensor Input: Maximum 20 mA; minimum 18; nominal 19.5V
   d. Software:
      1) Individual addressability
      2) Time schedule based control
      3) Daylight based control
      4) Astronomical schedule based control
      5) Occupancy based control
e. Power Metering

1) V, I, P Energy
   a) Accuracy is <2% from 0.5A to 10A load
   b) Accuracy is <5% below 0.5A

f. Environmental

1) Operational Temp: -40 deg. F to +150 deg. F (-40 deg. C to +65 deg. C)
2) Relative humidity: 0% to 95%
3) Ingress protection: IP66

g. Communication

1) Wireless protocol: ZigBee
2) Radio Frequency: 2.4 GHz
3) Transmit power: 20 dBm
4) Up to 1,000 ft. Line of sight between modules

h. Physical

1) Base diameter: 3.31 in. (84 mm); height: 2.61 in. (66.4 mm)
2) Weight: 0.44lbs (200g)
3) Color: black
4) Housing: UV stabilized PC

i. Regulatory

1) UL/916/773 cULus listed
2) Meets ASHRAE Standard 90.1 and CEC Title 24 requirements
3) FCC Part 15/ICES-003

N. Wireless Manager

1. The wireless manager shall collect, process and distribute lighting control information to control modules over a wireless mesh network. Each wireless manager typical can control up to 100 nodes.
2. The wireless manager is the central intelligence point in the system for the wireless devices. It collects signal information from control modules, it then determines appropriate brightness levels or ON/OFF status for each fixture and zone.
3. Specifications:
   a. Wireless Range: 100 ft. line of sign, 50 ft through standard walls
   b. Wireless manager Network Port – Ethernet 1-/100BaseTx Cat. 5 RJ45 port
   c. Dual PoE ports for daisy chain of up to 3 wireless managers
   d. Status LED on front of unit
   e. Configuration stored in non-volatile flash memory
   f. Weights: 115g (4.06oz) wireless manager 40g (1.41 oz) ceiling mounted kit
   g. Operating temperature range: 32 deg. F to 104 deg. F (0 deg. C to 40 deg. C)
   h. AES 128-bit encryption for wireless communication
   i. Dimensions: 2.81 in. W x 4.631 in. H x 0.78 D (71.37mm W x 117.6mm H x 19.81mm D)
   j. Includes Polaris 3D software
k. cULus Listed
   1) Energy Management Equipment (UL 916)

l. Complies with the following electromagnetic requirements:
   1) EN 61000-4-2
   2) EN 61000-4-4
   3) EN 61000-4-5

m. FCC Part 15/ICES-003

O. System Field Devices (Input and Output Modules)

1. General: Input Modules provide a common interface to low voltage occupancy sensors and photo sensors while Output Modules provide a common interface to 0-10V Dimming, Fixed Output Ballasts and/or 0-10V LED Drivers and analog dimming devices such as incandescent low-voltage dimming modules. These modules automatically self-address and detect the type of devices they are connected to (i.e., photo sensor, occupancy sensor, 0-10V ballast, 0-10V LED drivers or incandescent dimming module) and establish two-way communication between the system Control Unit (CU) and themselves. These individually addressable modules enable each lighting component to be independently controlled and configured to best meet the needs of the facility.
   a. Addressing: System Field Devices shall be individually addressable via Central Control Software.
   b. System shall automatically address individual nodes during system commissioning thus eliminating the need to pre-address devices or record serial numbers during installation.
   c. Modules shall at minimum meet the listed general, mechanical and environmental specifications set at below.

2. Provide Wireless site lighting control (WSLC) module for all site lighting unless specifically noted on the electrical site plan.

3. Air Gap Off
   a. Definition: Air Gap Off shall refer to the physical disconnection of AC power to the ballast or driver when “OFF” is selected either automatically or manually, thus ensuring maximum energy savings by eliminating off-state phantom power losses as well as ensuring that no potentially lethal high-voltage is present at the ballast or driver when the lights appear to be off (for life-safety reasons).
   b. Provisions: Provide an air-gap off relay for each control zone in the system. Where each fixture is to be controlled (dimmed and/or switched) independently, provide one relay per fixture. Where multiple fixtures are to be controlled (dimmed and/or switched), provide one relay per control zone, sized to handle both the inrush current as well as the maximum connected load, at the specified voltage.

4. General Specifications:
   a. Shall supply 12VDC (up to 24VDC) to sensors.
   b. Shall have 2 ports that accept 18 AWG, pre-fabricated, polarity independent quick connecting Class 2 communication bus that supplies 24 VDC.
   c. Two models, one rated for regular indoor use and other for use in damp locations such as basements, cold storage areas. shall be available.
d. Memory: Retains all system settings in non-volatile memory.

5. Mechanical Specifications:
   a. Wiring: The System Field Device shall not require wiring connections to the System apart from pre-terminated, quick connecting 18 AWG, polarity independent quick connecting Class 2 communication bus.

6. Environmental Specifications:
   a. Operating Temperature Range: -40 deg C to +55 deg C.
   b. Humidity: 0 percent to 100 percent RH condensing rated for damp locations.
      0 percent to 95 percent RH non-condensing rated for indoor locations.

P. Energy Control Unit

1. General: The Energy Control Unit (ECU) is a rack or wall mounted lighting control device that collects, processes and distributes lighting control information to System Field Devices and lighting controllers over a Class 2 communication bus. Each ECU has multiple Class 2 communication channels and can control a large quantity of nodes (sensors, lighting controllers, 0-10V Dimming, Fixed Output Ballasts and 0-10V LED Drivers.) per channel, per the manufacturers recommended maximum. The ECU is the central intelligence point for the area that it controls, collecting signal information from sensors, lighting controllers and personal control software and determining appropriate brightness levels or on/off status for each fixture or zone. Each ECU has an Ethernet connection for communication with a facility’s or tenant’s Local Area Network (LAN) to enable desktop personal control.
   a. Shall interconnect with other ECUs and System Server Unit (SSU) using standard Ethernet connection that employs TCP/IP protocol.
   b. Control units shall at minimum meet the mechanical, electrical, data, electromagnetic and environmental specifications listed below.

2. Mechanical Specifications:
   a. Shall mount in a standard 1 inch rack (1U width), or alternatively where no rack is shown, via an individual wall mount.

3. Electrical Specifications:
   a. Power Supply: 120V/60Hz/200W. Provide dedicated 120V receptacle fed from a dedicated normal power circuit; do not connect to a UPS or normal/emergency power source.

4. Data Specifications:
   a. Shall have 8 ports that accept 18 AWG, pre-fabricated, polarity independent quick connecting Class 2 communication bus that supplies 24 VDC
   b. Each ECU channel shall support up to 100 nodes or 800 nodes in total.
   c. Each ECU shall have two Ethernet 10/100Base - Tx Cat 5 RJ45 ports that employs TCP/IP protocol:
      1) Lighting Control Network
      2) Tenant LAN Access Point
d. Shall have a status LED on front of unit.
e. Shall have configuration stored in non-volatile flash memory.

5. Shall comply or exceed the following electromagnetic requirements:
   a. EN 61000-4-2
   b. EN 61000-4-4
   c. EN 61000-4-5
   d. FCC Part 15/ICES-003

6. Environmental Specifications:
   a. Operating Temperature Range: -20 deg C to +40 deg C.
   b. Humidity: 0 percent to 95 percent RH non-condensing.

Q. System Server Unit

1. General: System Server Unit (SSU) shall host the lighting control system database for all the lighting control devices. Server shall have the ability to:
   a. Remotely access a system in order to change system settings or configuration;
   b. Analyze system performance or energy data or generate system report;
   c. Record energy consumption with average sampling every 5 minutes for unlimited duration;
   d. Host the web interface required for the web enabled Personal Control Software or web based Central Control Software;
   e. Optionally can reside on a client server (virtual server) thus eliminating the need for dedicated physical hardware if desired;
   f. Interconnect with ECUs over standard Ethernet connection that employs TCP/IP protocol;

2. Hardware based servers shall at minimum meet the specifications listed below:
   a. Specifications:
      1) Mechanical Specifications:
         a) Shall mount in a standard 19 inch rack (1U width), or alternatively where no rack is shown, via an individual wall mount.
      b. Electrical Specifications:
         1) Power Supply: 120V/60Hz/200W. Provide dedicated 120V receptacle fed from a dedicated normal power circuit.
   c. Regulatory:
      1) FCC (US only) Class A.
      2) DOC (Canada) Class A.
      3) UL 60950.
      4) CAN/CSA-C22.2 No. 60950.
R. Communication Wire

1. Wiring: 18 AWG, pre-fabricated, polarity independent quick connecting wiring. The system shall have the capability to use both Class 1 and Class 2 wiring. The maximum connected length of wiring shall be 2500 ft. per channel.

2. Field Bus: Integrates peripheral devices such as 0-10V ballasts and/or 0-10V LED drivers, occupancy sensors, photo sensors, relay-based controls, power packs and low voltage wall controls into a complete, networked programmable lighting control system. Provides power to photo sensors, PIR occupancy sensors and dual-technology occupancy sensors. Devices may be connected randomly on the network and special termination of each network channel is not required.

3. Field bus shall at minimum meet the specifications listed below:

   a. Specifications:
      1) Class 2 communication bus.
      2) Prefabricated one ft., five ft., ten ft., 15 ft., 20 ft., 25 ft. and 50 ft. lengths.
      3) Daisy chain topology
      4) Prefabricated with 2-wire connectors.
      6) Power Supply: 12 VDC (up to 24 VDC) to sensors.

S. Conductors and Cables

1. Class 2 Control Cable: Multi-conductor cable with stranded-copper conductors not smaller than No. 18 AWG.

T. Lighting Control Panels

1. General

   a. Addressing: All lighting control panels shall be individually addressable via Central Control Software.
   b. Communication: All lighting control panels shall communicate via the same prefabricated, quick connecting low voltage wiring as all other devices.
   c. Wiring: Relay control panels shall be interconnected on the same field bus as all other system components.

U. Lighting Control System Software

1. Personal Control Software: Enables individuals in a building to control lighting levels in their workspace from their own desktop PC. User can control the light level of each fixture in their workspace or can control all of the fixtures together as a group. Preset lighting scenes may be stored, recalled and modified. This software shall have the capability of acting as a “virtual occupancy sensor” for the system by detecting keyboard or mouse activity on each PC for incremental occupancy status data.

   a. Technical Information:
      1) TCP/IP network traffic < 2kb/s.
2. **Web based Personal Control Software:** This feature allows individuals to control lighting levels in their workspace without the requirement for installation of software on client PCs. Individuals can access the interface through the web browser and perform individual fixture dimming control, on/off switching, modify and save preset lighting scenes.

3. **Technical Information:** Adobe Flash® based user interface.
   
a. **System Requirements:**
   
   1) Internet web browser with Flash® Player 8 or later.
   2) Internet/Intranet connection.
   3) SSU enabled and configured to host dynamic website.
   4) Network connection with access to a network-enabled CU.

4. **Web based Central Control Software:** Central control software application is used to commission, configure and manage the system. Every system parameter in a building (or campus of buildings) is configured for each individual user or space and baseline settings are established for each of the following (depending on the basis of design) system features:

   a. Daylight harvesting.
   b. Occupancy control.
   c. Smart time scheduling.
   d. Task tuning.
   e. Personal control.
   f. Load shedding.

   1) Software utilizes a web based interface that permits a user to easily navigate between zones, floors or different buildings and allows a user to zoom in or zoom out of specific areas of a building. Both 3-dimensional and 2-dimensional multi-floor views shall be available. System features such as creation of zone hierarchies, overlapping and support zone definitions, user access rights, timeout settings for occupancy sensors, calibration of light levels for daylight harvesting and the configuration of multiple time schedule profiles shall be available. A web based Graphical User Interface (GUI) application integral to the system will be used to develop a dynamic, real-time, point-and-click graphic of each floor plan with representation of all light fixtures, lighting controllers, sensors, and switches. A central system server will be provided to support system data base and enterprise control management.

5. **System Requirements:**

   a. Software must be able to run on a Windows Operating systems (Windows XP or newer) and also on Apple Mac Intel PCs (Mac OS 10.4 or newer).
   
b. Must support all common browsers, i.e.,

   1) Internet Explorer 6.0 or later
   2) Mozilla Firefox 3.0 or later
   3) Safari
   4) Google Chrome

   c. Network connection with access to network-enabled CUs.
d. Color gradient ("weather map" type) data view (see below for an example) shall be available to display the following criteria:

1) Current energy consumption
2) Current energy savings
3) Current fixture brightness
4) Current fixture status
5) Current occupancy data
6) Current load shedding status
7) Other custom modes that may be specified elsewhere

V. Photo Sensor:

Photo sensors shall at minimum meet the specifications listed below:

1. General Specifications:
   a. Shall be Class 2, low voltage.
   b. Ambient light sensor designed to interface directly with the analog input of the Lighting Control System.
   c. Sensor shall supply an analog signal to the ALCS proportional to the light measured.
   d. Sensor output shall provide for zero or offset based signal.
   e. Sensor shall be capable of a fully adjustable response in the range between 0 and 10,000 foot candles with a +/- 1 percent accuracy at 70 deg F.
   f. Input: 10VDC.
   g. Minimum Output: 0 VDC.
   h. Maximum Output: 10 VDC.
   i. Sensor housing shall be flame retardant and meet UL 94 HB standards.
   j. Operating Temp: -10 deg C to 60 deg C.
   k. The sensitivity adjustments shall be at sensor body, and outside of the sensor’s viewing angle.
   l. The sensor housing shall be flame retardant and meet UL 94HB standards

2. Interior:
   a. Indoor sensors shall have a Fresnel lens, with a 60 degree cone of response. The indoor sensor range shall be between 0 and 750 FC.

3. Exterior:
   a. Outdoor models shall have a hood over the aperture to shield the sensor from direct sunlight. The outdoor sensor circuitry shall be completely encased in an optically clear epoxy resin. Outdoor sensors shall mount to a standard threaded 1/2 in. conduit or fit a 1/2 in. knockout. The Outdoor sensor range shall be between 0 and 750 FC.

4. Atrium:
   a. The Atrium sensors shall have a translucent dome with a 180 degree field of view. Atrium sensor shall mount to a standard treaded 1/2 in. conduit or fit a 1/2 in. knockout. Atrium sensor range shall be from 2 to 2,500 FC.
5. Skylight:
   a. The Skylight sensors shall have a translucent dome with a 180 degree field of view. Skylight sensor shall mount to a standard threaded 1/2 in. conduit or fit a 1/2 in. Skylight sensor range shall be between 10 and 7,500 FC.

W. Occupancy Sensors

1. Environmental:
   Operating Temperature Range: 0ºC to 40ºC
   a. Relative Humidity: 0 percent to 95 percent non-condensing
   b. Ceiling Mount Occupancy/Vacancy Sensors
      1) Sensing mechanism:
      2) Dual technology (ultrasonic / passive infrared):
      3) Utilize multiple segmented lens, with internal grooves to eliminate dust and residue build-up.
      4) Utilize an operating frequency of 32kHz or 40kHz that shall be crystal controlled to operate within plus or minus 0.005 percent tolerance.
      5) Electrical: Rating: 12 VDC input voltage, up to 40 mA current draw.
      6) Sensors shall turn off or reduce lighting automatically after reasonable time delay when a room or area is vacated by the last person to occupy the space
      7) Sensor shall accommodate all conditions of space utilization and all irregular work hours and habits.
      8) Sensors shall be UL listed.
      9) Sensors shall be fully adaptive and adjust their sensitivity and timing to ensure optimal lighting control for any use of the space
      10) Sensors shall have field adjustable controls for time delay and sensitivity to override any adaptive features. Sensor timeouts shall be configurable by System software.
      11) Power failure memory:
      12) Controls incorporate non-volatile memory. Should power be interrupted and subsequently restored, settings and learned parameters saved in protected memory shall not be lost.
      13) Provide all necessary mounting hardware and instructions.
      14) Sensors shall be Class 2 devices.
      15) Indicate viewing directions on mounting bracket for all Ceiling mount sensors.
      16) Provide customizable mask to block off unwanted viewing areas for all ceiling mounted sensors using infrared technology. Field prepare proper maskings for each space to eliminate unnecessary sensing beyond the space in which the sensor is located.
      17) 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.

X. Examination

1. Site Verification: Verify that wiring conditions, which have been previously installed under other sections or at a previous time, are acceptable for product installation in accordance with manufacturer's instructions.
2. Inspection: Inspect all material included in this contract prior to installation. Manufacturer shall be notified of unacceptable material prior to installation.

Y. Installation

1. The Electrical Sub-contractor, as part of the work of this section, shall coordinate, receive, mount, connect, and place into operation all equipment. The Electrical Sub-contractor shall furnish all conduit, wire, connectors, hardware, and other incidental items necessary for properly functioning lighting control as described herein and shown on the plans (including but not limited to System Field Devices, 0-10V dimming ballasts, fixed output ballasts, 0-10V LED drivers and communication wire). The Electrical Sub-contractor shall maintain performance criteria stated by manufacturer without defects, damage, or failure.

2. Power: The contractor shall test that all branch load circuits are operational before connecting loads to sensor system load terminals, and then de-energize all circuits before installation.

3. Related Product Installation: Refer to other sections listed in Related Sections for related products’ installation.

Z. Sensor Installation

1. Adjust sensitivity to cover area installed
2. Set time delay on occupancy sensors that are connected to the lighting control system to the minimum. Time delays shall be controlled via Central Control Software.
3. Sensor shall be powered through Input Module. No external power packs shall be used for powering sensors.
4. Install occupancy sensors on vibration free stable surface.
5. Install atrium and skylight light sensor facing toward window or skylight.
6. Install interior light sensor in ceiling facing the floor.

AA. Wiring Installation

2. Wiring within Enclosures: Comply with NEC & CEC. Separate power-limited and non power-limited conductors according to conductor manufacturer's written instructions.
3. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
4. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

BB. Software Installation

1. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current site licenses for software.

CC. Field Quality Control

1. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
2. Perform the following field tests and inspections with the assistance of a factory-authorized service representative:
   a. Operational Test: After installing lighting controllers and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
   b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Lighting control devices will be considered defective if they do not pass tests and inspections.

4. Prepare test and inspection reports.

DD. Coordination with the owner

1. Owner meeting: The manufacturer shall supply factory trained representatives for a minimum of 16 hours (2) 8 hour sessions with the owner to review and complete the system programming data sheet and controllibility of the system. The Sequences as designed and shown on the contract documents shall be outlined and explained to the owner and any input/changes from the owner shall be incorporated as long as overrides of energy code mandated controls are not suggested.

EE. Commissioning Requirements

1. Commissioning: The manufacturer shall supply factory trained representatives for a minimum of 24 hours to commission the lighting control system. Manufacturer shall start up all lighting control equipment and verify that it meets the requirements of this specification.

2. Training: As part of the standard commissioning process, the manufacturer shall train the owner’s representatives in the operation of the system to a maximum of 4 hours per building. Manufacturer shall also provide owner’s representatives with system operating manuals together with a system training video. Specific training on the operation of the tunable white lighting shall be provided. In addition to the 4 hours an additional 4 hours of training shall be provided for spaces utilizing tunable white light.

3. Technical Support: The manufacturer shall supply 24/7 technical telephone support to the client. If the manufacturer does not provide 24/7 support, they must provide a list of contacts (names and cell phone numbers) in the event of a system failure during non-business hours.

4. Replacement components: The manufacturer shall be able to ship replacement parts within 24 hours for any component that fails during the warranty period.

5. Extended Service Coverage: Maintenance agreements shall be available from the manufacturer to provide service for the system both during and after the warranty period.

6. Requests for commissioning shall be at least two weeks prior to date desired for commissioning.

7. Electrical Sub-contractor shall perform functional testing under the guidance of commissioning agent and in accordance with factory specified guidelines.

8. Factory appointed personnel shall provide commissioning services for the lighting control system.
   a. Verify proper communication over control wires.
   b. Map addresses of occupancy sensors (via Input Modules), light level sensors (via Input Modules), lighting controllers to control units and system server.
   c. Map all system data to appropriate BACnet points and assist BMS sub-sub-contractor in programming all points into the BMS system and verifying their proper functionality.
   d. Verify communication to control units and system server.
e. Configure occupancy sensors, light level sensors, lighting controllers and other contacts to suit design specifications.
f. Configure and program lighting control sequences as described on contract documents.
g. Demonstrate to Owner and Engineer proper operation of all areas the system is installed.

**FF. Testing**

1. Upon completion of all line, load and interconnection wiring, and after all fixtures are installed and lamped, a qualified factory representative shall completely configure and test the system.
2. At the time of checkout and testing, the owner’s representative shall be thoroughly instructed in the proper operation of the system.

**GG. Demonstration**

1. Engage a factory-authorized service representative to train Owner's maintenance personnel and building supervisors to adjust, operate, utilize, troubleshoot, conduct software installation, and maintain lighting controls and software training for PC-based control systems. Provide up to eight hours of on-site training with audio and video recorded. Provide a hard copy of manuals, instructional videos, and recorded training session(s) on CD or DVD.
2. Submit shop drawings indicating outline dimensions, connection and support points, weight, specified ratings and materials.
3. Submit product data indicating standard model design tests and options.
4. Submit manufacturer's installation instructions.

**HH. OPERATION AND MAINTENANCE DATA**

1. Submit operation and maintenance data under.
2. Include procedures for cleaning unit, and replacing components.

**II. QUALITY ASSURANCE**

1. Manufacturer: Company specializing in distribution transformers with Five years Documented experience.

2.17 **LADDER TRAY/WIREWAYS**

**A.** Provide ladder tray where indicated on drawings. Ladder tray shall be as manufactured by b-line, “ladder type”, or equal. Provide all hangers required.

**B.** Wireway:

1. This specification covers NEMA type 1 wireway used to house ad protect communication cable. The wireway system shall consist of wireway and appropriate fittings to complete the installation per the electrical drawings.
2. Metal wireway (NEMA type 1) is to be utilized in dry interior locations only as covered in article 362 part a of the national electrical code, as adopted by the national fire protection association and as approved by the American National Standards Institute. The wiremold c” or “sp” series is listed by underwriters' laboratories under file no. E137690 guide zoyx.
3. The wireway system specified herein shall be the “c” or “sp” system as manufactured by the wiremold company. Systems of other manufacturers may be considered equal if, in the opinion, and the written approval of the engineer, they meet all the performance standards specified herein.

4. The wireway and all system components must be UL Listed in full compliance with their standard ul870, “electrical wireways, auxiliary gutters and associated fittings”. It shall be manufactured from 16-gauge cold rolled steel, finished in ASA 61 gray powder coat paint. All sizes larger than 6 in. x 6 in. shall be manufactured from 14-gauge cold rolled steel, finished in ASA 61 gray powder coat paint. A factory installed divider shall be available to separate power and low voltage wiring housed in the same wireway sections.

5. A full complement of fittings for the raceway shall be available including, but not limited to, 45 deg. and 90 deg. flat, vertical inside and outside elbows, tee and cross fittings, couplings for joining sections of wireway, reducers, hangers, end blanks, a field installed divider and all other components necessary to make the system workable. The fittings shall have an ASA 61 gray powder coat paint finish to match the wireway.

6. Prior to and during installation, refer to system layout drawing containing all elements of the system. Installer shall comply with detailed manufacturer’s instruction sheets which accompany system components as well as complete system instruction sheets, whichever is applicable.

7. All wireway systems shall be mechanically continuous and connected to all electrical boxes and cabinets, in accordance with manufacturer’s installation sheets.

8. All connections shall be checked to make sure they are correctly tightened and to insure that all wireway shall be electrically continuous and bonded in accordance with the national electric code for proper grounding.

9. All wireway systems shall be installed complete. Work shall include fastening all wireway and appropriate fittings to install a complete wireway system as indicated on the electrical and/or communication drawings and in the applicable specifications.

2.18 SEALS

A. Water Tight Seals

1. Conduits entering from the exterior or below grade shall have water tight fittings on the outside and on the inside of the conduit.

   a. Fittings on the outside of the conduit shall be O-Z Gedney type FSK or equal. Provide type WSK if penetration is within two feet of the high water table. Provide grounding attachment.
   b. Fittings on the inside of the conduit shall be O-Z Gedney type CSBI or equal. Provide type CSBG if penetration is within two feet of the high water table. Provide a blank fitting to seal spare or empty conduits.
   c. O-Z Gedney type CSM or equal fitting may be used when sealing within a sleeve or cored hole.

2. Submit on seals to be used.

B. Environmental Seals

1. Provide seals on raceways exposed to widely different temperatures, as in refrigerating or cold storage areas. Install seal to prevent circulation of air from warmer to colder sections through the raceway.
C. Hazardous Area Seals

1. Provide explosion proof seals as required by the Electric Code.
   a. Explosion-proof exhaust fans.

D. Smoke and Fire Stopping Seals

1. Provide a seal around raceways or cables penetrating full height walls (slab to slab), floors or ventilation or air handling ducts so that the spread of fire or products of combustion shall not be substantially increased.
2. Penetrations through fire-resistant-rated walls, partitions, floors or ceilings shall be firestopped using approved methods and NRTL listed products to maintain the fire resistance rating.
3. Fire stopping in sleeves or in areas that may require the addition or modification of installed cables or raceways shall be a soft, pliable, non-hardening fire stop putty. Putty shall be water resistant and intumescent. Provide for all sleeves and raceways.
4. Fire stopping in locations not likely to require frequent modification shall be NRTL listed putty, caulk or mortar to meet the required fire resistant rating.
5. Box penetrations into a fire rated wall or shaft shall have a fire stopping pad installed on the back of the box.
6. Firestopping of cable trays or busways through walls shall be within a non-hardening putty or with seal bags.
7. Firestopping materials shall be NRTL listed to UL 1479 (ASTM E814). Installation methods shall conform to a UL firestopping system. Submit specifications and installation drawings for the type of material to be used. Firestopping materials shall be as manufactured by 3M, International Protective Coatings Corp., RayChem or approved equal.

2.19 UNDERGROUND DUCTBANKS

A. General: Furnish and install the ductbanks as herein specified and as shown on drawings.

B. Division of Work:

1. The Construction Manager shall be responsible for the work and material required for the following:
   a. Excavation
   b. Backfill
   c. Installation of handholes/manholes
   d. Brick or concrete collars to bring handhole frames and covers up to grade. Installation of frames and collars which are to be furnished by the Electrical Subcontractor.
   e. Concrete Encasement

2. All other material, equipment, and labor required for the complete ductbank shall be furnished and installed by the Electrical Subcontractor under this Section, including the following:
   a. Service raceways.
   b. Grounding material.
   c. Ductbank warning tape.
d. Furnishing pre-cast handholes/manholes.
e. Conduit spacers.

C. Materials:

1. Conduit: UL listed, schedule 40 PVC in accordance with NEMA standard TC-2. Schedule EB PVC is acceptable where encased in concrete. See BASIC MATERIALS SECTION.

2. Conduit Supports (duct system): Shall be molded plastic with interlocking lugs and skeletonized structure, minimum separation 3 in.

3. Tags: Non-ferrous metal or fibre, 1/4 in. high letters.

4. Warning tape shall be yellow polyethylene 4 mil thick, 6 in. wide terratape, similar to REEF Industries, Houston, Texas and shall be installed above all ductbanks both high and low tension.


D. Duct System:

1. The duct system shall consist of Schedule 40 PVC conduit except where otherwise specified. The size and number of conduits shall be as indicated on the drawings. Provide a pull wire in each conduit.

2. The entire length between handholes and end of ductbank shall be excavated and graded before any conduit is laid.

3. The ductbank shall be set on undisturbed earth.

4. The conduit shall be installed so that top is a minimum of 36 in. below finished grade unless otherwise indicated, and shall be laid to a minimum grade of 4 in. for each 100 feet of length. Duct system shall drain to manholes/handholes.

5. Changes in direction shall be made by long sweep bends, minimum radius 25 feet except that at the end of a run, within ten feet of termination. Manufactured ends may be used having a minimum radius of 36 inches.

6. Conduit base and intermediate spacers shall be installed a maximum of 5 feet on centers. Spacers shall not be placed one above the other, but shall be staggered a minimum of 6 in.

7. All conduit joints shall be made watertight by means of a sealing compound before the coupling is installed. Joints in conduit shall be staggered, minimum space between joints in adjacent conduit shall be 6 inches.

8. When the required number of conduits have been installed, securely tie the assembly together at distances not exceeding 7 ft. Tie shall consist of three turns of No. 18 iron wire. Separate ties required for low tension and high tension conduit runs.

9. Duct envelope shall be vibrated to eliminate voids.

10. Ductbanks shall not be covered until the conduit installation has been observed by the utility company and Architect.

11. Warning tape shall be installed during backfilling and shall be placed approximately 12 in. above the conduits.

12. After the installation is completed, each conduit shall be cleaned and identified. A standard flexible mandrel and a stiff bristle brush shall be pulled through each conduit. The mandrel shall not be less than 12 in. long and the diameter approximately ¼ in. less than the conduit.
2.20  VARIABLE FREQUENCY DRIVES (VFD’S)

A. The variable frequency drives (VFD’s) shall be solid state, with a Pulse Width Modulated (PWM) output waveform (VVI, six-step, and current source drives are not acceptable). The VFD package as specified herein shall be enclosed in a NEMA 1 enclosure, completely assembled and tested by the manufacturer. The VFD shall employ a full wave rectifier (to prevent input line notching), DC Line Reactor, capacitors, and Insulated Gate Bipolar Transistors (IGBT’s) as the output switching device (SCR’s, GTO’s and Darlington transistors are not acceptable). The drive efficiency shall be 97 percent or better at full speed and full load. Fundamental power factor shall be 0.98 at all speeds and loads.

B. Specifications at 208 volts:

1. Input VAC +/-10 percent (capable of operation to 550 VAC), 3 phase, 48-63Hz. Output 0 - Input Voltage, 3 phase, 0 to 500 Hz for drives up to 75 HP; 0 to 120 Hz for drives over 75 HP. Operation above 60 Hz. shall require programming changes to prevent inadvertent high speed operation. Environmental operating conditions: 0 to 40 C @ 3 klz switching frequency, 0 to 3300 feet above sea level, less than 95 percent humidity, non-condensing. Units shall be UL, CUL and CA approved.

C. All VFD’s shall have the following standard features:

1. All VFD’s shall have the same customer interface, including digital display, keypad and customer connections; regardless of horsepower rating. The keypad is to be used for local control, for stepping through the displays and menus.

2. The VFD shall give the user the option of either (1) displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last reference revised, or (4) cause a Warning to be issued, if the input reference (4-20mA or 2-10V) is lost; as selected by the user. The VFD shall provide a programmable relay output for customer use to indicate the loss of reference condition.

3. The VFD’s shall utilize plain English digital display (code numbers and letters are not acceptable). The digital display shall be a 40-character (2 line X 20 characters/line) LCD display. The LCD shall be backlit to provide easy viewing in any angle. All set-up parameters, indications, faults, warnings and other information must be displayed in words to allow the user to understand what is being displayed without the use of a manual or cross-reference table.

4. The VFD’s shall utilize pre-programmed application macro’s specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time.

5. The VFD shall have the ability to automatically restart after an overcurrent, overvoltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between reset attempts shall be programmable. If the time between reset attempts is greater than zero, the time remaining until reset occurs shall count down on the display to warn an operator that a restart will occur.

6. The VFD shall be capable of starting into a rotating load (forward or reverse) and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).

7. The VFD shall be equipped with an automatic extended power loss ride-through circuit which will utilize the inertia of the load to keep the drive powered. Minimum power loss ride-through shall be one-cycle, based on full load and not inertia. Removing power from the motor is not an acceptable method of increasing power loss ride-through.

8. The customer terminal strip shall be isolated from the line ground.
9. Prewired 3-position Hand-Off-Auto switch and speed potentiometer. When in "Hand", the VFD will be started, and the speed will be controlled from the speed potentiometer. When in "Off", the VFD will be stopped. When in "Auto", the VFD will start via an external contact closure, and its speed will be controlled via an external speed reference.

10. The drive shall employ three current limit circuits to provide trip free operation.

11. The Slow Current Regulation limit circuit shall be adjustable to 125 percent (minimum) of the VFD's variable torque current rating. This adjustment shall be made via the keypad, and shall be displayed in actual amps, and not as percent of full load. The Rapid Current Regulation limit shall be adjustable to 170 percent (minimum) of the VFD's variable torque current rating. The Current Switch-off limit shall be fixed at 255 percent (minimum, instantaneous) of the VFD's variable torque current rating. The overload rating of the drive shall be 110 percent of its variable torque current rating for 1 minute every 10 minutes, and 140 percent of its variable torque current rating for 2 seconds every 15 seconds, input line fuses standard in the drive enclosure. VFD shall have a DC Line Reactor to reduce the harmonics to the power line and to increase the fundamental power factor.

12. The VFD shall be optimized for a 4 kHz carrier frequency to reduce motor noise and provide high system efficiency. The carrier frequency shall be adjustable by the start-up engineer in ACH 501 units. The VFD shall have a manual speed potentiometer in addition to using the keypad as a means of controlling speed manually.

D. All VFD's to have the following adjustments:

1. Five programmable critical frequency lockout ranges to prevent the VFD from continuously operating at an unstable speed.

2. PI Setpoint controller shall be standard in the drive, allowing a pressure or flow signal to be connected to the VFD, using the microprocessor in the VFD for the closed loop control.

3. Two programmable analog inputs shall accept a current or voltage signal for speed reference, or for reference and actual (feedback) signals for PI controller. Analog inputs shall include a filter; programmable from 0.01 to 10 seconds to remove any oscillation in the input signal. The minimum and maximum values (gain and offset) shall be adjustable within the range of 0-20 MA and 0-10 Volts. Additionally, the reference must be able to be scaled so that maximum reference can represent a frequency less than 60 Hz, without lowering the drive maximum frequency below 60 Hz.

4. Six programmable digital inputs for maximum flexibility in interfacing with external devices. One digital input is to be utilized as a customer safety connection point for fire, freeze, and smoke interlocks (Enable). Upon remote, customer reset (reclosure of interlock), drive is to resume normal operation.

E. The following operating information displays shall be standard on the VFD digital display. The display shall be in complete English words (alpha-numeric codes are not acceptable):

- Output Frequency
- Motor Speed (RPM, percent or Engineering units)
- Motor Current
- Calculated Motor Torque
- Calculated Motor Power
- DC Bus Voltage
Output Voltage
Heatsink Temperature
Analog Input Values
Keypad Reference Values
Elapsed Time Meter
kWh meter

F. Speed Command Input shall be via:

2. Two Analog inputs, each capable of accepting a 0-20mA, 4-20mA, 0-10V, 2-10V signal. Input shall be isolated from ground, and programmable via the keypad for different uses.
3. Floating point input shall accept a three-wire input from a Dwyer photohelic (or equivalent type) instrument.

G. Accessories to be furnished and mounted by the drive manufacturer.

1. Customer Interlock Terminal Strip—provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external interlocks and start/stop contacts shall remain fully functional whether the drive is in hand, Auto or Bypass.
2. All wires to be individually numbered at both ends for ease of troubleshooting.
3. Door interlocked thermal magnetic circuit breaker which will disconnect all input power from the drive and all internally mounted options. The disconnect handle shall be thru-the-door type, and be padlockable in the "Off" position.
4. Manual transfer to line power via contactors. Include motor thermal overload and fuse or circuit breaker protection while in bypass operation. A three position selector switch to control the bypass contactor and the drive output contactor is to be mounted on the enclosure door. When in the "Normal" mode, the bypass contactor is open and the drive output contactor is closed. In the "Test" position both contactors are open, and in the "Bypass" position, the drive output contactor is open, and the bypass contactor is closed. The drive output contactor shall also open when a stop command is given, isolating the motor from the drive. Start/stop signals and safety interlocks will work in drive and bypass modes.
5. Pilot lights or LED’s shall be provided for indication of "Normal" operation, "Bypass" operation, and "External Fault". All pilot lights shall be push-to-test type.
6. Service contactor (drive input contactor) which provides the ability to service the drive (electrically isolate the drive while in bypass operation without having to remove power from the motor). The service contactor shall open when the drive is switched to bypass, and also be controlled by a switch which is mounted inside the drive enclosure so that its access is limited to service personnel only.
7. A class 20 bimetallic thermal motor overload relay shall be provided to protect the motor in bypass.
H. Compliance to IEEE - 519

1. The VFD manufacturer shall provide calculations specified to this installation showing that the Total harmonic Distortion for the VFD’s, reflected into the electrical distribution system is limited to the level defined by IEEE - 519 (latest edition) for general systems. Harmonic analysis shall be included with VFD submittal for approval by the engineer.

2. The VFD manufacturer shall conduct on site harmonic measurements before and after startup of the VFD’s. Results of the measurements, showing harmonic contribution of the VFD’s, shall be provided to the engineer one month after start up.

3. Three phase A. C. input, 3 percent line reactors (externally mounted ahead of diode bridge) shall be provided as a minimum, with all VFD’s. The line reactors are to provide attenuation of line side voltage transients, thus preventing overload trips or other unnecessary V.F.D. shutdown, and provide a reduction in harmonic distortion.

4. Line reactors shall have the following requirements:
   a. Two or three percent line impedance.
   b. 150 percent continuous current rating for one minute.
   c. Saturation rating no less than 2.5 times the continuous current rating.
   d. U.L. recognized.

I. General: Install variable frequency drives where indicated, in accordance with manufacturer's published installation instructions, complying with recognized practices to ensure that variable frequency drives comply with requirements and serve intended purposes.

J. Access: Provide access space around control panels for service as indicated, but in no case less than that recommended by manufacturer.

K. Support: Install drive control panels on walls where indicated on drawings. Provide necessary Unistrut and structural steel to provide adequate support as required by manufacturer.

L. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

   1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

M. Start-Up

   1. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer.

N. Adjusting and Cleaning:

   1. Alignment: Check compatibility of control panel to motor and where necessary, adjust frequency and provide necessary filters to assure noise free operation of motors. Verify response from control panel to motor to assure turn down ratio specified and that static pressure signals are being received and that drives are controlling as specified and within recommended tolerances by manufacturer. Provide start-up report prepared by manufacturers representative to assure operation is as specified.

   2. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
O. Acceptable Manufacturers:

1. ABB
2. Allen – Bradley
3. Siemens
4. Square D
5. Or equal

PART 3 -EXECUTION

3.1 WORK COORDINATION AND JOB OPERATIONS

A. Equipment shall not be installed in congested and possible problem areas without first coordinating installation of same with other trades. Relocate electrical equipment installed in congested or problem areas should it interfere with the proper installation of equipment to be installed by other trades.

B. Particular attention shall be directed to coordination of lighting fixtures and other electrically operated equipment requiring access which is to be installed in ceiling areas. Coordinate with other trades, the elevations of equipment in hung ceiling areas to insure adequate space for installation of recessed fixtures before said equipment is installed. Conflicts in mounting heights and clearances above hung ceilings for installation of recessed lighting fixtures or other electrically operated equipment requiring access shall be brought to the attention of Architect for a decision prior to equipment installation.

C. Furnish to General Trades Contractor and other subcontractors information relative to portions of electrical installation that will affect other trades sufficiently in advance so that they may plan their work and installation.

D. Obtain from other trades information relative to electrical work which he, the Electrical Subcontractor, is to execute in conjunction with installation of other trades’ equipment.

E. Lighting fixtures in mechanical spaces or utility/ storage rooms shall only be installed after all mechanical equipment is in place.

3.2 PLANS AND SPECIFICATIONS

A. Plans:

1. Drawings showing layout of electrical systems indicate approximate location of raceways, outlets, and apparatus. Runs of feeders and branch circuits are schematic and are not intended to show exact routing. Final determination as to routing shall be governed by structural conditions and as indicated on the approved coordination drawings.

B. Specifications:

1. Specifications supplement drawings and provide specifics pertaining to methods and material to be used.
3.3 IDENTIFICATION

A. Equipment shall be marked for ease of identification as follows:

1. Provide screw-on nameplates on switchboards, panelboards, F.A. terminal cabinets, starters, and disconnect switches. Nameplates to be of black phenolic with white engraving. For starters and disconnect switches lettering shall be minimum of ¼ in. high. Nameplates on panelboards shall have the following information.
   a. Line 1 - Panel designation in ½ in. high letters.
   b. Line 2 - Utilization voltage in 3/8 in. high letters.
   c. Line 3 - Distribution source “Fed from” ¼ in. high letters.

2. Neatly typed directory cards listing circuit designations shall be fastened inside the cover of panelboards. Spare circuits shall be penciled.

3. Provide Signage on all rooms that contain Fire alarm control equipment within it. Where a Fire alarm control panel is located within a separate room provide permanent signage that reads “FIRE ALARM CONTROL PANEL INSIDE” with minimum 7 in. high by 10 in. width with 2-inch high block letters a 0.5 in. letter stroke - white letters on a contrasting red background. The sign shall be permanently attached, at normal eye level to the door leading to the fire alarm control panel(s).

4. Color coding schedules. If there is more than a single system voltage, different voltages shall have separate color codes, as previously specified. A copy of the color code schedule shall be affixed to each secondary switchboard and distribution panel and shall be of the phenolic nameplate type as previously specified. A typewritten color code schedule shall also be affixed, under plastic, inside each panelboard door.

5. Outlet boxes both concealed and exposed shall be identified as to panel origination and circuit number by means of fibre pen on the inside of coverplate.

6. Special system outlet boxes concealed above hung ceilings shall be identified as to system by spray painting during roughing. The following systems shall be identified.
   a. Fire Alarm - red.
   d. Sound - green.

7. Wiring device plates on devices connected to normal-emergency circuits shall be red in color.

8. All conductors in boxes larger than standard outlet boxes, in all wireways, and trench headers. shall be grouped logically and be identified.

9. Grounding conductors and neutrals shall be labeled in panels, and wireways. as to circuits associated with.

10. Emergency system wiring shall comply with 700.10(A).

11. Power and raceway identification:
   a. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
   b. Colors for Raceways Carrying Circuits at 600 V or Less:
   c. Black letters on an orange field.
   d. Legend: Indicate voltage and system or service type (Power, Lighting, Emergency, Control).
   e. Colors for Raceways Carrying Circuits at More Than 600 V:
   f. Black letters on an orange field.
g. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch high letters.

h. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

i. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: 4-inch wide black stripes on 10-inch centers diagonally over orange background that extends full length of raceway. Stop stripes at legends.

j. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

k. Write-On Tags: Polyester tag, with corrosion-resistant grommet and cable tie for attachment to conductor or cable. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

12. Armored metal clad cable identification:

   a. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

   b. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

13. Power and Control Cable identification:

   a. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

   b. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

   c. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

   d. Write-On Tags: Polyester tag, with corrosion-resistant grommet and cable tie for attachment to conductor or cable. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

   e. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

14. Conductor Identification materials:

   a. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

   b. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

   c. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

   d. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

   e. Write-On Tags: Polyester tag, with corrosion-resistant grommet and cable tie for attachment to conductor or cable. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
15. Underground warning tape:
   a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines but not less than 4 mils thick and 6 inches wide.
   b. Printing on tape shall be permanent and shall not be damaged by direct-burial service.
   c. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
   d. Color and Printing:
      1) Comply with ANSI Z535.1 through ANSI Z535.5.
      2) Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
      3) Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

16. Warning labels and signs:
   a. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
   b. Baked-Enamel Warning Signs:
   c. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. Nominal size, 7 by 10 inches.
   d. Metal-Backed, Butyrate Warning Signs:
   e. Weather-resistant signs, non-fading, preprinted, cellulose-acetate butyrate signs with galvanized-steel backing; and with colors, legend, and size required for application. Nominal size 10 by 14 inches.
   f. Safety signs shall warn of potential electrical hazard and shall include, but are not limited to, the following legends:
   g. Multiple power source warning.
   h. Workspace clearance warning.
   i. Potential electric arc flash hazard.

17. Equipment identification labels:
   a. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.
   b. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

18. Cable ties:
   a. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, Type 6/6 nylon.
   b. Minimum Width: 3/16 inch.
   c. Color: Black except where used for color-coding.
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d. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, Type 6/6 nylon.

e. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, self-locking. UL 94 Flame Rated.

19. Verify identity of each item before installing identification products. Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and required by code.

20. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

21. Apply identification devices to surfaces that require finish after completing finish work.

22. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

23. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

24. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

25. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

26. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

27. Outdoors: UV-stabilized nylon.

28. In Spaces Handling Environmental Air: Plenum rated.

29. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

30. Renovation Projects: For alterations and additions to existing facilities, use existing identification system. Where systems have not been standardized, use the identifying and marking system specified in this standard.

31. Distribution Equipment: Identify major components of the distribution system (such as circuit breakers, switches, transformers, switchboards, panelboards, motor control centers) with nameplates. Nameplates on disconnect switches and control stations shall identify the equipment served.

32. Identification Schedule:

a. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for service, feeder, and branch circuits more than 30A and 120V to ground: Identify with self-adhesive vinyl label applied at 10-foot maximum intervals.

b. Power-Circuit Conductor Identification, 600 V or Less: Identify conductors in the panels, pull and junction boxes, manholes, handholes.

1) Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors for ungrounded service, feeder and branch-circuit conductors as specified in Division 26 Section "Low-Voltage Power Conductors".

a) Factory applied continuous color coding for conductors No.8 AWG and smaller.

b) Field-applied, color coding conductor tape: For conductors No.6 AWG and larger. Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made.
2) Lighting and Receptacle Outlet Boxes: Identify with the panel and circuit number.

c. Power-Circuit Conductor Identification, above 600 V: For conductors in the vaults, pull and junction boxes, manholes and handholes, use write-on tags.
e. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
f. Terminal Blocks: Attach numbered nameplates to terminal blocks which require identification numbers; use the designations shown on the wiring diagrams. Install nameplate at the top of vertically mounted terminal blocks and at the end of horizontally mounted terminal blocks. Indicate the individual terminal point designation shown on the wiring diagrams.
g. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
h. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in the finished spaces.
i. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Apply warning, caution, and instruction signs where required by the referenced Electrical code, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install self-adhesive warning labels or baked-enamel warning signs with approved legend where instructions or explanations are needed for system or equipment operation. Install metal-backed, butyrate warning signs for outdoor items.
j. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch high letters for emergency instructions at equipment used for power transfer, load shedding and other emergency operations.
k. Safety sign for the switchboards and panelboards: Provide a sign to warn qualified persons of potential electric arc flash hazard.
l. All electrical distribution equipment and mechanical/plumbing/fire protection equipment fed from the electrical distribution system shall contain in addition to the identification requirements listed in this section shall be labelled where they are fed from. For example Distribution panel 4DP1A is fed from MSB-1A, its label shall be “4DP1A fed from MSB-1A” submit full labeling scheme for review and approval.
m. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to the disconnect switches and protection equipment, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1) Labeling Instructions:
   a) Indoor Equipment: Self-adhesive, laminated acrylic or melamine label.
   b) Outdoor Equipment: Engraved, laminated acrylic.
   c) Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
2) Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved laminated acrylic. Panelboard directories shall identify the load name and location (i.e. AHU-1, Room #, FCU-1, Room #).

3.4 PROTECTION AND CLEANUP

A. Protection:
   1. Materials and equipment shall be suitably stored and protected from weather.
   2. During progress of work, pipe and equipment openings shall be temporarily closed so as to prevent obstruction and damage.
   3. Be responsible for maintenance and protection of material and equipment until final acceptance.

B. Cleanup:
   1. Keep job site free from accumulation of waste material and rubbish. Remove all rubbish, construction equipment, and surplus materials from site and leave premises in a clean condition.
   2. At completion, equipment with factory finished surfaces shall be cleaned and damaged spots touched up with the same type paint applied at factory.
   3. Particular attention is called to Section 110-12(c) of the NEC, which requires that internal parts of electrical equipment not be contaminated by construction operations.

3.5 PORTABLE OR DETACHABLE PARTS

A. Retain possession of and be responsible for spare parts, portable and detachable parts, and other removable portions of installation including fuses, keys, locks, blocking clips, inserts, lamps, instructions, drawings, and other devices or materials that are relative to and necessary for proper operation and maintenance of the system until final acceptance, at which time such parts shall be installed or turned over to the Owner, as the case may be.

3.6 SAFETY PRECAUTIONS

A. Provide proper guards, signage, and other necessary construction required for prevention of accidents and to insure safety of life and property. Remove any temporary safety precautions at completion.

3.7 MOUNTING HEIGHTS

A. All electrical equipment shall be mounted at the following heights unless noted or detailed otherwise on drawings. Notes on architectural drawings shall supersede those noted below or detailed on the electrical drawings. If mounting height of an electrical component is questionable, obtain clarification from Architect before installation.

1. Duplex convenience outlets, microphone outlets, and telephone outlets - 18 inches.
2. Light switches, pushbutton stations, HOA switches, and all other toggle or control switches for the operation of heating, ventilating, and air conditioning, plumbing, and general service - 48 inches.
3. Clock outlets - 84 inches.
5. Fire alarm audio visual signals - 80 inches or 6 inches below ceiling, whichever is lower.
6. Panelboards for lighting, power, telephone, and other auxiliary systems - 78 in. to top.
7. Equipment located in lobbies shall be located as detailed on architectural drawings or as directed by Architect.
8. All receptacles, light switches, fire alarm signals, and clocks sharing a common location shall be symmetrically arranged.
9. Exterior and interior wall brackets shall be as detailed on architectural drawings or as directed by Architect.

B. Mounting heights given are from finished floor to centerline. In the case of a raised floor, surface of raised floor is the finished floor.

3.8 WORKMANSHIP AND INSTALLATION METHODS

A. Work shall be installed in first-class manner consistent with best current trade practices. Equipment shall be securely installed plumb and/or level. Flush-mounted outlet boxes shall have front edge flush with finished wall surface. No electrical equipment shall be supported by work of other trades. Cable systems shall be supported and not draped over ducts and piping or laid on ceiling suspension members. Lighting fixtures shall be installed to agree with Architects reflected ceiling plans.

B. Supports:

1. Support work in accordance with best industry practice and by use of standard fittings.
2. In general, walls and partitions will not be suitable for supporting weight of panelboards, dry type transformers and the like. Provide supporting frames or racks extending from floor slab to structure above.
3. Provide supporting frames or racks for equipment, intended for vertical surface mounting in free standing position where no walls exist.
4. Supporting frames or racks shall be of standard angle, standard channel or specialty support system steel members, rigidly bolted or welded together and adequately braced to form a substantial structure. Racks shall be of ample size to assure a workmanlike arrangement of equipment.
5. Provide 3/4 in. thick painted plywood mounting surfaces in all electric and telephone areas and for all equipment on free standing racks. All plywood shall be fire retardant and painted both sides and edges with 2 coats of white paint.
6. No work for exposed installations in damp locations shall be mounted directly on any building surface. In such locations, flat bar members or spacers shall be used to create a minimum of ¼ in. air space between building surfaces and work.
7. Nothing (including outlet, pull and junction boxes and fittings) shall depend on electric raceways or cables for support. All outlet, pull, and junction boxes shall be independently supported.
8. Nothing shall rest on, or depend for support on, suspended ceiling or its mounting members.
9. Support surface or pendant mounted lighting fixtures:
   a. From outlet box by means of an interposed metal strap, where weight is less than five pounds.
   b. From outlet box by means of a hickey or other direct threaded connection, where weight is from five to fifty pounds.
   c. Directly from structural slab, deck or framing member, where weight exceeds fifty pounds.
   d. Pendant lighting fixtures shall be supported by threaded rods in non-public areas and by manufacturers standard tube hangers with swivel aligner and canopy in public areas. Provide non-standard pendant lengths where required to mount fixtures at elevations either called for on drawings or as shown in architectural elevations.
10. Support recessed lighting fixtures directly from structural slabs, decks or framing members, by means of jack chain or air craft cable, one at each end of fixture at opposite corners.

11. Where support members must of necessity penetrate air ducts, provide airtight sealing provisions which allow for a relative movement between the support members and the duct walls.

12. Provide channel sills or skids for leveling and support of all floor mounted electrical equipment.

13. Where permitted loading is exceeded by direct application of electrical equipment to a slab or deck, provide proper dunnage to distribute the weight in a safe manner.

14. Support metallic raceways by either running within steel frame or hung from the building frame. Anything hung from building frame shall be attached with metallic fasteners.

C. Fastenings:

1. Fasten electric work to building structure in accordance with the best industry practice.

2. Where weight applied to attachment points is 100 pounds or less, fasten to building elements of:
   a. Wood -- with wood screws.
   b. Concrete and solid masonry -- with bolts and expansion shields.
   c. Hollow construction -- with toggle bolts.
   d. Solid metal -- with machine screws in tapped holes or with welded studs.

3. Where weight applied to attachment points exceeds 100 pounds, fasten as follows:
   a. At field poured concrete slabs, provide inserts with 18 in. minimum length slip-through steel rods, set transverse to reinforcing steel.
   b. Where building is steel framed, utilize suitable auxiliary channel or angle iron bridging between structural steel elements to establish fastening points. Bridging members shall be suitably welded or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.

4. Floor mounted equipment shall not be held in place solely by its own dead weight. Provide floor anchor fastenings. Floor mounted equipment over 72 inches in height shall also be braced to nearest wall or overhead structural elements.

5. For items which are shown as being mounted at locations where fastenings to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging to building structural elements.

6. Fastenings for metallic raceways using the fastening as support shall be of the metallic type. Fastenings to hold raceways or cables in place may be via traps.

D. General Raceway Installation:

1. Install the various types of raceways in permitted locations as previously specified. All raceways shall be run concealed. Consult Architect for instruction for raceways which must be exposed in public spaces.

2. Raceways for normal emergency or emergency only wiring cannot contain other conductors.

3. Raceways shall be properly aligned, grouped, and supported in accordance with code. Exposed raceways shall be installed at right angles to or parallel with structural members. Concealed raceways may take most direct route between outlets.

4. Raceways run on trapeze hangers shall be secured to the trapeze.
5. Raceways shall be continuous and shall enter and be secured to all boxes in such a manner that each system shall be electrically continuous from service to all outlets. Provide grounding bushings and bonding jumpers where raceways attach to painted enclosures or terminate below equipment.

6. Where raceways enter boxes, cabinets, tap boxes, other than those having threaded hubs, a standard locknut shall be used on the outside and locknut and bushing on the inside.

7. Where raceways terminate below equipment and there is no direct metal to metal continuity, provide grounding bushings on raceways and interconnect with equipment grounding conductor.

8. All empty raceways shall be provided with a pull wire.

9. All raceway sleeves, stub-ups, or stub-outs, where not connected to a box or cabinet, shall be terminated with a bushing.

10. All raceway joints shall be made up tight and no running threads will be permitted.

11. Where raceways are cut, the inside edge shall be reamed smooth to prevent injury to conductors.

12. All vertical raceways passing through floor slabs shall be supported.

13. Raceways shall not be installed in concrete slabs above grade or below waterproofed slabs.

14. Electric raceways and/or sleeves passing through floors or walls shall be of such size and in such location as not to impair strength of construction. Where raceways alter structural strength or the installation is questionable, the structural engineer shall be contacted for approval.

15. Raceways shall not run directly above or below heat producing apparatus such as boilers, nor shall raceways run parallel within 6 inches of heated pipes. Raceways crossing heated pipes shall maintain at least a 1 inch space from them.

16. Raceways shall be installed in such a manner as to prevent collection of trapped condensates, and all runs shall be arranged to drain.

17. Raceways passing between refrigerated and non-refrigerated spaces and those penetrating enclosures with air movement shall be provided with seals.

18. Raceways feeding fire and jockey pumps shall be rigid metal conduit either run below slab or inside 2 hour rated enclosure. Final connections to motors shall be luidite flexible conduit.

19. Where two alternate wiring methods interconnect such as EMT to flexible metal conduit, an outlet box shall be provided.

20. All empty raceways entering building and all sleeves or core drilled openings through floors shall be sealed.

21. Each exterior raceway or assembly in a ductbank shall be provided with continuous warning tape installed 12 inches above raceway or ductbank.

22. Underground rigid non-metallic raceways where allowed and run as a ductbank encased in concrete shall be installed with plastic spacers to ensure a separation of 3 inches between raceways. Top of ductbanks shall be 30 inches below grade, unless otherwise detailed.

23. Elbows and extensions of rigid non-metallic raceway systems which penetrate slabs shall be rigid or intermediate metal conduit.

24. Raceways used for transformer connections shall be flexible type and shall contain a grounding conductor.

25. Raceways entering building through foundation wall into a basement area shall be provided with wall entrance seals or with other acceptable waterproofing method.
26. Underground non-metallic raceways shall be fully surrounded by a selected backfill to prevent more than the desired deflection and, in power raceways is needed to provide room for heat dissipation and good compaction of backfill. Separation Between Direct-Buried, Non-encased Ducts: 3 inches minimum for like services, and 12 inches minimum between power and signal ducts, unless shown otherwise on the drawings. Raceways formation for non-encased ducts shall be built up layer by layer. After each layer is placed, the selected backfill shall be placed over it to the specified depth. This fill should be spread evenly and compacted to provide continuous support for the next tier of raceways. Any temporary spacers used should be removed from each layer of raceway as soon as backfill is completed in that layer. A maximum of 9 conduits shall be grouped in the same trench unless otherwise noted on the drawings.

27. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

28. Run conduit concealed in finished areas above suspended ceilings, in wall spaces. Exposed conduit runs in finished areas require Architect's approval. Properly group conduit runs. Install conduit parallel to walls, structure and ceilings, and support with proper hangers and clamps. Running conduits at the bottom of structural members in exposed conditions is not allowed. Check door swings before installing back boxes for switches and receptacles.

29. Where conduit passes through a building expansion joint, use weatherproof, telescopic type expansion fittings which permit at least 4 inches of movement.

30. Form bends in conduit by means of a conduit bending machine or by an approved hickey. To fasten conduit to outlet boxes, cabinets, use locknuts and insulated throat bushings of compatible material.

31. Cut conduit ends square, thread conduit, and ream to remove burrs and sharp edges. Field threads shall be of the same type and have the same effective length as factory cut threads. Turns, wherever required in exposed conduit runs, shall be made by the use of factory-made bends, or field-made bends that meet the requirements of this Section and Electric Code. In the event of a multiplicity of conduits making the same turn, a steel junction box with a removable steel cover may be used. Offsets and bends for changes in elevation of exposed conduit runs shall be made at walls or beams and not in open spaces between walls or beams. Rout conduits required to avoid interfere with the operation or maintenance of equipment.

32. Plug or cap conduit ends as soon as conduit is installed, to prevent entrance of moisture or other debris during construction. Do not pull wire into any conduit until the conduit system is complete.

33. Drawings, in relation to the routing of conduits, are diagrammatic. Except where additional conduits may be required to avoid derating of branch circuits, elsewhere within this Section, the number and size of conduits and wire shall be furnished and installed as indicated by the drawings. Coordinate routing of conduits in the field with the building structure. Run conduit in straight lines parallel and perpendicular to walls, beams, and columns and with right angle bends and threaded conduit fittings. Maintain 12 inches clearance between conduit and surface with temperatures exceeding 104 degrees F.

34. Conduits passing through floors, walls and beams shall be of such size, number, and in such locations so as not to impair the strength of the construction.

35. Rout raceways in ceiling spaces in an orderly and organized manner, and to eliminate or minimize the number of junction boxes required. Support and secure conduits by means of rods, clamps and other conduit support devices approved by the Architect. Do not use wire to support conduits.

36. Where rigid metal conduit is threaded in the field, use a standard conduit cutting die providing 3/4 inch taper per foot.
37. Conduit and EMT runs shall be mechanically and electrically continuous from service entrance to outlets. Secure conduit to cabinet, junction box, pull box or outlet box with locknut outside and bushing inside, or with liquid-tight, threaded, self-locking, cold-weld wedge adapter. Locknuts and bushings or self-locking adapters will not be required where conduits are screwed into tapped connections. Before installing conductions, protect vertical conduit runs that terminate in bottoms of wall boxes or cabinets from entrance of foreign material.

38. Size rigid steel conduit, EMT and flexible metallic conduit required by the referenced Electrical Code, except as otherwise specified or shown on the drawings. Check raceway sizes to determine that equipment grounding conductor fits in same raceway with phase and neutral conductors to meet Massachusetts Electrical Code percentage of fill requirements.

39. Where conduit is secured rigidly on opposite sides of building expansion joints, and where runs of exposed conduit are long and subject to stress, provide expansion fittings capable of safely deflecting and expanding to twice the distance of structural movement. Provide separate external copper bonding jumper secured with grounding straps on each end of fitting.

40. Install a pull or junction box every 100 feet of straight conduit run, and wherever there is an equivalent of four 90 degree elbows or a total of 360 degree bend. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

41. Install sealing fittings at following points, and elsewhere as shown:

a. Where conduits enter or leave hazardous areas equipped with explosion proof lighting fixtures, switches, receptacles, and other electrical devices.
b. Where conduits pass from warm to cold locations.

42. Pull cords: In each empty raceway, provide nylon fishing line having tensile strength not less than 200 lbs, or provide No. 14 AWG steel wire. Label each end of each line or wire with a securely attached tag which indicates the location of the other end.

43. Liquid-tight type flexible conduits installed in the air-handling plenum space shall be with a plenum-rated outer jacket.

44. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

E. General Outlet Box Installation:

1. Boxes shall be set flush with finish surface and provided with proper type extension rings or plaster covers. Thru the wall boxes are not permitted. Check device or fixture to be mounted to box to ensure box orientation is proper.
2. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling-in operation.
3. Plug unused openings on all remove knockouts.
4. Where required for horizontal and vertical alignment of boxes in stud partitions, bar hangers spanning two studs shall be used. Device boxes for insertion type receptacles shall be provided with far side box supports where there are less than two entering nonflexible raceways, and where bar hangers are not provided.
5. Boxes flush mounted in fire rated partitions and on opposite sides of the partition shall be separated by a distance of 24 inches in accordance with UL listing for the box.
6. Locations of outlets indicated on drawings are approximate. For items exposed to view, refer to architectural drawings and coordinate locations with masonry joints, panel joints, ceiling grids, and structural members.
7. In case of conflict with standard mounting heights and device alignment, consult Architect prior to roughing.
8. Check all door swings on architectural drawings to ensure lighting switches are installed on strike side of door.
9. The right to make any reasonable change in location of outlets prior to roughing is reserved by Architect. "Reasonable change" shall be interpreted as movement within 10 feet of location shown.
10. Obtain dimensioned plan from Architect for floor outlets.
11. Outlet boxes for use where surface metal raceways are allowed shall be of a type specifically designed to be used with such surface metal raceway systems.

F. Conductor Installation:

1. No conductors shall be pulled into individual raceways until such raceway system is complete and free of debris. No harmful lubricants shall be used to ease pulling.
2. All conductors shall be wired so that grounded conductor is unbroken; switches in all cases being connected in ungrounded conductor.
3. Connections throughout the entire job shall be made with solderless type devices of approved design satisfactory to Inspector of Wires.
4. All taps and splices shall be insulated equal to that of conductor insulation.
5. All conductors of each feeder in pull boxes and wireways shall be grouped, tied together, supported, and identified.
6. All conductors in panelboards and other wiring enclosures shall be neatly formed and grouped.
7. All conductors of emergency only and/or normal/emergency shall be run in separate raceway systems to final outlet box.
8. Provide support for conductors in vertical raceways in accordance with Article 300-19.
9. Strip insulation from conductors with approved tools and only of sufficient length for proper termination. Cutting of conductor stranding is unacceptable.
10. Taps from paralleled conductors shall be of a type which tap each conductor, such as ILSCO "PTA" series.
11. Grounding conductors are to be identified as to associated power circuits.

G. Type MC Cable Installation:

1. Where cable is permitted under the products section, the installation of same shall be done in accordance with code and the following:

   a. Cable shall be supported in accordance with code. Tie wire is not an acceptable means of support. Horizontally run cable supports such as Caddy WMX-6, and clamps on vertical runs such as Caddy CJ6 shall be used. Where cables are supported by the structure and only need securing in place, then ty-raps will also be acceptable. Ty-raps are not acceptable as a means of support. All fittings, hangers, and clamps for support and termination of cables shall be of types specifically designed for use with cable, i.e., romex connectors not acceptable.
   b. Armor of cable shall be removed with rotary cutter device equal to roto-split by Seatek Co., not with hacksaw.
   c. Use split "insuliner" sleeves at terminations.
   d. Any cable system used in conjunction with isolated ground circuits shall have both an isolated ground conductor and an equipment ground conductor.
H. Stranded Conductor Installation:

1. If Contractor selects stranded conductors for #10 AWG and smaller, terminate such conductors as follows:
   a. No stranded conductor may be terminated under a screwhead. Provide insulated terminal lugs for all screw connections equal to Thomas & Betts "STA-KON" type RC with forked tongue and turned up toes. Installation of lugs shall be done with compression tool such as T&B WT-145C which prevents opening of tool until full compression action is completed.
   b. Backwired wiring devices shall be of clamp type; screw tightened. Force fit connections not allowed.

2. Stranded conductors will not be allowed for fire alarm work.

I. Accessibility:

1. Electrical equipment requiring service or manual operation shall be accessible.
2. Work switches for equipment within accessible hung ceiling spaces, such as fan powered terminal boxes, shall be located at terminal box, and so located so as to be accessible.

J. Vibration Elimination: All equipment connections to rotating equipment or equipment capable of vibration shall be made up by flexible raceways.

K. Wiring Device Gaskets: Provide wiring device gaskets at coverplates where device is mounted in wall separating conditioned and non-conditioned spaces.

3.9 FEEDER CIRCUITS

A. Provide feeders as called for on the drawings.
B. Feeders shall be defined as any circuit originating from the distribution panels.
C. All feeder conductors shall be continuous from origin to panel or equipment termination without splicing.
D. All feeders shall be conductors pulled into raceways. Cable systems are not allowed for feeders unless specifically indicated.

3.10 BRANCH CIRCUITS

A. Provide all branch circuit wiring and outlets for a complete and operating system. The system shall consist of insulated conductors connected to the panelboards and run in raceways or as cable systems if permitted under products section, as required to the final outlet and shall include outlet boxes, supports, fittings, receptacles, plates, fuses, etc.
B. Physical arrangement of branch circuit wiring shall correspond to circuit numbering on drawings. Combining of circuits and raceways will be allowed up to a 3 phase, 4 wire circuit in a single raceway, unless shared neutrals are not allowed by other sections of this Division, or are indicated as separate neutrals on the drawings. Any combination of homeruns such as this, however, shall be indicated on record drawings. When a common grounded conductor is used for more than one circuit, the arrangement shall be such that a receptacle, fixture, or other device may be removed or disconnected without disconnecting the grounded conductor for other circuits. Ground fault circuit breakers and isolated ground outlets shall be wired with separate neutrals and separate grounding conductors per circuit. A consistent phase orientation shall be adhered to throughout project at terminations.

C. Circuits feeding three phase equipment shall not be combined into common raceways, unless specifically indicated.

D. All wiring in panelboards and cabinets shall be neatly formed and grouped.

3.11 FIREPROOFING AND WATERPROOFING

A. General: Install firestop systems at all new and existing fire-rated construction where penetrated by the Work of this Section.

B. Refer to Section 078400 - Firestopping, for all installation requirements for maintaining integrity of fire-rated construction at penetrations.

3.12 CUTTING AND PATCHING

A. Openings through new wall surfaces will be provided by General Conditions if Electrical contractor gives suitable notice as erection of surface proceeds. If suitable notice is not given, Electrical contractor shall then be responsible for cost of corrective work required.

B. Patching will be provided by the trade responsible for the surface to be patched.

3.13 ELEVATOR COORDINATION

A. Elevator Electrical Work:

1. Several items pertaining to elevator electrical system shall be provided by Electrical Subcontractor as follows:

   a. Power source to elevator machine room including fused disconnect switch and wiring between disconnect switch and controller for each elevator.
   b. Power source to elevator machine room including fused disconnect switch (120 volt) for elevator signal system and cab light for each cab.
   c. Light, switch, and GFCI receptacle in each pit.
   d. Light, switch, and GFCI receptacle in machine room.
   e. Junction box in machine room with five control modules from fire alarm system for elevator recall to prevent cab opening on a fire floor.
   f. Junction box in machine room for cab telephone with one 1 in. conduit with (2) CAT 6 telephone cables to main telephone demarcation backboard.
   g. Power to automatic damper in hoistway penthouse louver.
   h. Power wiring to elevator sump pump.
3.14 MECHANICAL SYSTEM COORDINATION

A. The Mechanical System contractor will be providing various items of mechanical services equipment and control apparatus. In general, Electrical contractor shall connect up power wiring to this equipment.

B. The Mechanical and Electrical contractor shall closely coordinate their respective portions of work.

C. If, due to local regulations, electric heating equipment furnished by the mechanical systems subcontractor is required to be installed by licensed electricians in order to allow connection by Electrical contractor's licensed electricians, it will then be Mechanical contractor's responsibility to engage and pay for services of such licensed electricians.

D. Power wiring to be provided by Electrical contractor is the line voltage power supply wiring. Control wiring is responsibility of Mechanical System contractor unless specifically indicated on electrical drawings, or in this Division of the specifications. Temperature Control contractor shall refer to electrical drawings for location of all magnetic starters.

E. 120-volt control wiring source to temperature control panel is the responsibility of Electrical contractor.

3.15 DISTRIBUTION EQUIPMENT TESTING

A. All panelboards, individual motor starters, main distribution panel, motor controls, feeder conductors, and emergency systems shall be tested in accordance with the following. In general, all tests shall be done in accordance with the 2017 Acceptance Testing Specifications of the International Electrical Testing Association.

B. The Testing Subcontractor may be an independent contractor or a manufacturer of the equipment, which is to be tested.

C. Test report forms, delineating tests to be made, and method of recording same shall be submitted prior to commencing work. Test reports when submitted shall include interpretation of results and recommendation for any corrective work required.

D. Main Distribution Panel:

   1. Visual Inspection:
      a. Check for foreign material within bus enclosure.
      b. Check for missing hardware.
      c. Inspect entire assemblies for transit damage or factory defects.
      d. Check for all bus dimensions and bracing per specifications.
      e. Check ratings of current transformers and potential transformers.
      f. Check ratings of all protective relays per drawings.

   2. Physical Inspection:
      a. Torque all bus hardware to proper tension.
      b. Circuit breaker interlocks all work properly.
      c. All doors and hinged panels open and close properly.
      d. Relay blocking removed from all control and protective relays.
      e. All circuit breakers operate, close and trip mechanically.
f. Torque all feeder conductors to terminal manufacturers’ recommendations.

3. Electrical Testing:
   a. Breakers operated electrically trip and close from local and remote positions.
   b. All circuit breakers calibrated to manufacturer’s respective time current curves as specified.
      1) Long time pick-up amps.
      2) Long time delay tripping at 300 percent of current setting.
      3) Resets okay at 80 percent of pick-up value.
      4) Short time pick-up current.
      5) Short time delay trip time at 105 percent of setting.
      6) Instantaneous minimum pick-up current.
   c. All protective relays calibrated to manufacturer’s characteristic time curves for pick-up, drop-out, instantaneous and time delay.
   d. All instruments calibrated for accuracy.
   e. Protective relay schemes to be electrically tested by primary injection of current through current transformers and the tripping of associated circuit breakers.
   f. Insulation resistance tests made on all circuit breakers, line to load breaker open, line to ground breaker closed, 3 poses tested individually. Switchgear bus to be tested phase to phase and phase to ground with Megohometer type instrument. Relays also to be insulation resistance tested.

E. Magnetic Starters:
   1. Visual inspection to determine:
      a. Shipping damage.
      b. Proper bussing and contactor sizes.
      c. Correct overload relay heater ratings. Any incorrectly sized overloads shall be replaced by the contractor who originally provided same.
   2. Electrical Testing:
      a. Electrical operation of control relays, timing relay, and contactor coils.
      b. Insulation resistance test on all current carrying bus to ground and between phases.
      c. Calibration check of overload heater to ascertain tripping point and time delay at 300 percent of heater rating.

F. Conductors:
   1. All secondary service conductors and all feeder conductors from switchboards and distribution panels shall be tested.
   2. Visual and mechanical inspection
      a. Conductor connections shall be torque tested to manufacturer's recommended values.
3. **Electrical Tests:**
   a. Perform insulation resistance test on each conductor with respect to ground and adjacent conductor.
   b. Perform continuity test to insure proper conductor connection.

G. **Emergency Systems:**

1. **Engine Generator** - Prior to the emergency generator test specified under the emergency generator specification, the testing contractor shall perform the following:
   a. Visual and Mechanical Inspection:
      1) Inspect for physical damage.
      2) Compare nameplate rating and connection with specifications and single line diagram.
      3) Inspect for proper anchorage and grounding. Verify engine cooling and fuel system integrity.
   b. Electrical and Mechanical Tests:
      1) Perform a dielectric absorption test on generator winding with respect to ground. Determine polarization index.
      2) Perform phase rotation test to determine compatibility with load requirements.
      3) Test protective relay devices in accordance with applicable sections of these specifications.
      4) Perform dc over potential test between winding and ground.

2. **Automatic Transfer Switches:**
   a. Visual and Mechanical Inspection:
      1) Inspect for physical damage.
      2) Verify that the short circuit withstand rating exceeds the available short circuit duty.
      3) Compare equipment nameplate information and connections with single line diagram and report any discrepancies.
      4) Check switch to ensure positive interlock between normal and alternate sources. (Mechanical and Electrical).
      5) Check tightness of all control and power connections.
      6) Perform manual transfer operation.
      7) Ensure manual transfer warnings are attached and visible to operator.
   b. Electrical Tests:
      1) Perform insulation resistance tests phase-to-phase and phase-to-ground with switch in both source positions.
      2) Measure contact resistance in normal and alternate source position.
      3) Set and calibrate in accordance with the project electrical engineer's specifications.
         a) Voltage and frequency sensing relays.
         b) All time delay relays.
c) Engine start and shutdown relay.

4) Perform automatic transfer by tests.
   a) Simulating loss of normal power.
   b) Return to normal power.
   c) Simulating loss of emergency power on return to normal.
   d) Simulate all forms of single phase conditions.

5) Monitor and verify correct operation and timing.
   a) Normal voltage sensing relays.
   b) Engine start sequence.
   c) Time delay upon transfer.
   d) Alternate voltage sensing relays.
   e) Automatic transfer operation.
   f) Interlocks and limit switch function.
   g) Timing delay and retransfer upon normal power restoration.
   h) Engine cool down and shutdown feature.

3.16 FAULT CURRENT, ARC FLASH AND COORDINATION STUDY

A. Trade Contract:
   1. Work of this Section is part of the Electrical trade contract. Refer to Section 26 00 00 for additional information about this work.

B. Related Documents:
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

C. Scope:
   1. The Electrical SubContractor shall furnish short-circuit and protective device coordination studies as prepared by the manufacturer of the switchgear provided for the project. Mechanical equipment shall be included in the study in accordance with NEC 440.4(B) and require documentation per 440.10(B).
   2. The Electrical SubContractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in the current version of NFPA 70E -Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE Standard 1584 – 2002, the IEEE Guide for Performing Arc-Flash Calculations.
   3. The scope of the studies shall include new distribution equipment supplied by switchgear manufacturer furnishing the electrical distribution equipment for this project.

D. References:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
      b. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
      c. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
d. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings  


f. IEEE 1584 -Guide for Performing Arc-Flash Hazard Calculations


a. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers  
b. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures  
c. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis  

3. The National Fire Protection Association (NFPA)

a. NFPA 70 -National Electrical Code, latest edition  
b. NFPA 70E – Standard for Electrical Safety in the Workplace

E. Submittals For Review/Approval:

1. The studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the study may cause delays in equipment shipments, approval from the Engineer may be obtained for a preliminary submittal of data to ensure that the selection of device ratings and characteristics will be satisfactory to properly select the distribution equipment. The formal study will be provided to verify preliminary findings.

F. Submittals For Construction:

1. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. A minimum of five (5) bound copies of the complete final report shall be submitted. For large system studies, requiring more than five copies of the report will be provided without the section containing the computer printout of the short- circuit input and output data. Electronic PDF copies of the report shall be provided upon request.  

2. The report shall include the following sections:

a. Executive Summary including Introduction, Scope of Work and Results/Recommendations.  
b. Short-Circuit Methodology Analysis Results and Recommendations  
c. Short-Circuit Device Evaluation Table  
d. Protective Device Coordination Methodology Analysis Results and Recommendations  
e. Protective Device Settings Table  
f. Time-Current Coordination Graphs and Recommendations
g. Arc Flash Hazard Methodology Analysis Results and Recommendations including the details of the incident energy and flash protection boundary calculations, along with Arc Flash boundary distances, working distances, Incident Energy levels and Personal Protection Equipment levels.

h. Arc Flash Labeling section showing types of labels to be provided. Section will contain descriptive information as well as typical label images.

i. One-line system diagram that shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location, device numbers used in the time-current coordination analysis, and other information pertinent to the computer analysis.

G. Qualifications:

1. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the responsible charge and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.
2. The Registered Professional Electrical Engineer shall be an employee of the equipment manufacturer.
3. The approved engineering firm shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analyses it has performed in the past year.

H. Computer Analysis Software:

1. The studies shall be performed using SKM Systems Analysis Power*Tools for Windows (PTW) software program.

I. Studies:

1. The Electrical SubContractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E -Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D. This study shall also include short-circuit and protective device coordination studies.

J. Data:

1. Electrical SubContractor shall furnish all data as required for the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Electrical SubContractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.
2. Source combination may include present and future motors and generators.
3. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner, or General Contractor.
4. If applicable, include fault contribution of existing motors in the study. The Electrical SubContractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

K. Short-Circuit Analysis:

1. Transformer design impedances shall be used when test impedances are not available.
2. Provide the following:
   a. Calculation methods and assumptions
   b. Selected base per unit quantities
   c. One-line diagram of the system being evaluated that clearly identifies individual
equipment buses, bus numbers used in the short-circuit analysis, cable and bus
connections between the equipment, calculated maximum short-circuit current at
each bus location and other information pertinent to the computer analysis
   d. The study shall include input circuit data including electric utility system
characteristics, source impedance data, conductor lengths, number of conductors
per phase, conductor impedance values, insulation types, transformer impedances
and X/R ratios, motor contributions, and other circuit information as related to the
short-circuit calculations.
   e. Tabulations of calculated quantities including short-circuit currents, X/R ratios,
equipment short-circuit interrupting or withstand current ratings and notes
regarding adequacy or inadequacy of the equipment rating.
   f. Results, conclusions, and recommendations. A comprehensive discussion section
evaluating the adequacy or inadequacy of the equipment must be provided and
include recommendations as appropriate for improvements to the system.

3. For solidly-grounded systems, provide a bolted line-to-ground fault current study for
applicable buses as determined by the engineer performing the study.

4. Protective Device Evaluation:
   a. Evaluate equipment and protective devices and compare to short circuit ratings
   b. Adequacy of switchgear, motor control centers, and panelboard bus bars to
   withstand short-circuit stresses
   c. Switchgear Manufacturer shall notify Owner in writing, of any circuit protective
devices improperly rated for the calculated available fault current.

L. Protective Device Time-Current Coordination Analysis:

1. Protective device coordination time-current curves (TCC) shall be displayed on log-log
scale graphs.
2. Include on each TCC graph, a complete title with descriptive device names.
3. Terminate device characteristic curves at a point reflecting maximum symmetrical or
asymmetrical fault current to which the device is exposed.
4. Identify the device associated with each curve by manufacturer type, function, and, if
applicable, tap, time delay, and instantaneous settings recommended.
5. Plot the following characteristics on the TCC graphs, where applicable:
   a. Electric utility’s overcurrent protective device
   b. Medium voltage equipment overcurrent relays
   c. Medium and low voltage fuses including manufacturer’s minimum melt, total
   clearing, tolerance, and damage bands
   d. Low voltage equipment circuit breaker trip devices, including manufacturer’s
tolerance bands
   e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault
   protection curves
   f. Medium voltage conductor damage curves
   g. Ground fault protective devices, as applicable
   h. Pertinent motor starting characteristics and motor damage points, where
   applicable
   i. Pertinent generator short-circuit decrement curve and generator damage point
j. The largest feeder circuit breaker in each motor control center and applicable panelboard.

6. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

a. Provide the following:

1) A One-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known.

2) A sufficient number of log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.

3) Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devices, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.

4) The study shall include a separate, tabular printout containing the recommended settings of all adjustable overcurrent protective devices, the equipment designation where the device is located, and the device number corresponding to the device on the system one-line diagram.

5) A discussion section which evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.

6) Switchgear Manufacturer shall notify Owner in writing of any significant deficiencies in protection and/or coordination. Provide recommendations for improvements.

M. Arc Flash Hazard Analysis:

1. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2009, Annex D. The arc flash hazard analysis shall be performed in conjunction with the short-circuit analysis (Section 2.03) and the protective device time-current coordination analysis (Section 2.04).

2. The flash protection boundary and the incident energy shall be calculated at significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

3. Circuits 240V or less fed by single transformer rated less than 125 kVA may be omitted from the computer model and will be assumed to have a hazard risk category 0 per NFPA 70E.

4. Working distances shall be based on IEEE 1584. The calculated arc flash protection boundary shall be determined using those working distances.

5. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.
6. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location in a single table. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum. Conversely, the maximum calculation will assume a maximum contribution from the utility. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable as well as any stand-by generator applications.

The Arc-Flash Hazard Analysis shall be performed utilizing mutually agreed upon facility operational conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.

7. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors should be decremented as follows:

a. Fault contribution from induction motors should not be considered beyond 5 cycles.

For each piece of ANSI rated equipment with an enclosed main device, two calculations shall be made. A calculation shall be made for the main cubicle, sides, or rear; and shall be based on a device located upstream of the equipment to clear the arcing fault. A second calculation shall be made for the front cubicles and shall be based on the equipment’s main device to clear the arcing fault. For all other non-ANSI rated equipment, only one calculation shall be required and it shall be based on a device located upstream of the equipment to clear the arcing fault.

8. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

9. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

10. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. A maximum clearing time of 2 seconds will be used based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

11. Provide the following:

a. Results of the Arc-Flash Hazard Analysis shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, working distances, personal-protective equipment classes and AFIE (Arc Flash Incident Energy) levels.

b. The Arc-Flash Hazard Analysis shall report incident energy values based on recommended device settings for equipment within the scope of the study.

c. The Arc-Flash Hazard Analysis may include recommendations to reduce AFIE levels and enhance worker safety.

N. Field Adjustment:

1. Electrical SubContractor shall adjust relay and protective device settings according to the recommended settings table provided by the coordination study.
2. Electrical SubContractor shall make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

3. Switchgear manufacturer shall notify the design engineer in writing of any required major equipment modifications.

O. Arc Flash Labels:

1. Electrical SubContractor shall provide a 4.0 in. x 4.0 in. Brady thermal transfer type label of high adhesion polyester for each work location analyzed.

2. The labels shall be designed according to the following standards:
   a. UL969 – Standard for Marking and Labeling Systems
   b. ANSI Z535.4 – Product Safety Signs and Labels
   c. NFPA 70 (National Electric Code) – Article 110.16

3. The label shall include the following information:
   a. System Voltage
   b. Flash protection boundary
   c. Personal Protective Equipment category
   d. Arc Flash Incident energy value (cal/cm²)
   e. Limited, restricted, and prohibited Approach Boundaries
   f. Study report number and issue date

4. Labels shall be printed by a thermal transfer type printer, with no field markings.

5. Arc flash labels shall be provided for equipment as identified in the study and the respective equipment access areas per the following:
   a. Floor Standing Equipment - Labels shall be provided on the front of each individual section. Equipment requiring rear and/or side access shall have labels provided on each individual section access area. Equipment line-ups containing sections with multiple incident energy and flash protection boundaries shall be labeled as identified in the Arc Flash Analysis table.
   b. Wall Mounted Equipment – Labels shall be provided on the front cover or a nearby adjacent surface, depending upon equipment configuration.

P. General Use Safety labels shall be installed on equipment in coordination with the Arc Flash labels. The General Use Safety labels shall warn of general electrical hazards associated with shock, arc flash, and explosions, and instruct workers to turn off power prior to work.

3.17 WASTE MANAGEMENT

A. Separate and recycle materials and material packaging in accordance with Waste Management Plan and to the maximum extent economically feasible and place in designated areas for recycling.

B. Set aside and protect materials suitable for reuse and/or remanufacturing.

C. Separate and fold up metal banding; flatten and place along with other metal scrap for recycling in designated area.

D. Coordinate with Section 017419 – CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL.
3.18 TRAINING

S. All training shall be scheduled with the user. Training shall be videotaped and a DVD delivered to the Owner. Refer to each specific system for amount of training required.

3.19 SPARE PARTS/ATTIC STOCK:

T. REQUIREMENTS:

1. Provide attic stock of the following quantities and parts for each piece of equipment as follows:

<table>
<thead>
<tr>
<th>Equipment/Unit</th>
<th>Parts Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED Lights</td>
<td>LED Drivers</td>
<td>2 of each type</td>
</tr>
<tr>
<td></td>
<td>Single faced exit signs</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Double faced exit signs</td>
<td>3</td>
</tr>
<tr>
<td>Fire Alarm</td>
<td>Smoke detectors of each type</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>(Duct, ceiling, fire detectors)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Detector</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Pull stations</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Spare printer ribbon</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Extra set of keys and tools for access to locked and tamperproof components</td>
<td>3</td>
</tr>
</tbody>
</table>

3.20 STORAGE AND INSTALLATION OF EQUIPMENT

A. The electrical subcontractor shall store and install electrical equipment and wiring listed for dry locations only after the building is watertight.

END OF SECTION
SECTION 270000

TECHNOLOGY
(Filed-Sub-Sub Bid Required)

PART 1 - GENERAL

1.1 FILED SUB-SUB BIDS

A. Section 270000 TECHNOLOGY shall be a Filed Sub-Sub Bid of Section 16000, requiring a Paragraph “E” Listing on the FORM FOR SUB-BID.

B. Work included under this SECTION is shown on all Drawings. Examine all drawings for requirements affecting the work of this Section.

C. The DCAM category that this Contractor shall be certified is: Telecommunications Systems.

1.2 GENERAL PROVISIONS

A. The General Conditions, Supplementary General Conditions and General Requirements shall be included in and made a part of this Section.

B. Examine all Drawings and other Sections of the Specification for requirements affecting the Work of this Section.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 260000 – Electrical General Provisions

B. Section 260000 – Basic Materials and Methods

1.4 TELEPHONE/DATA SYSTEM

A. General:

1. All telecommunication and data system interconnecting wiring, terminal blocks, connections, terminations, shall be furnished and installed by a licensed and certified installer.

2. The Electrical Subcontractor (E.C.) shall furnish and install all raceways, and outlet boxes as indicated on the drawings, including pull wires for all empty raceways, and all access panels. Backboards (3/4" thick by 78" high) which shall be mounted at the main telephone entrance, MDF room will be provided by General Contractor.

3. General Requirements:
   a. Applicable Standards:
      1) ANSI/EIT/TIA-492AAAA, Detail Specification for 50 um core Diameter/125 um Cladding Diameter Class Ia Multimode, Graded-Index Optical Waveguide Fibers.
    ANSI/TIA/EIA-606, Administration Standard for the Telecommunications
    Infrastructure of Commercial Buildings.
    J-STD 607-A, Commercial Buildings Grounding and Bonding
    Requirements for Telecommunications.
    Note: The Commercial Building Telecommunications Cabling Standard:
    Part 1 General Requirements and Balanced Twisted-Pair Cabling
    Standard is under development at the time of this manual ANSI/TIA/EIA-
    606, Color Coding of Fiber Optic Cabling being printed.

b. Contractor is responsible for strict adherence to Massachusetts electrical codes,
    and all other applicable codes.

c. The contractor is responsible for obtaining municipal permits and inspections as
    mandated by law.

d. All penetrations in station raceway shall have rubber or equivalent grommets to
    prevent cable cuts on trough edges.

e. The I.T. sub contractor is responsible for all aspects of MDF construction. Refer to
    drawings for configuration of MDF.

f. All cabling at the MDF shall be neatly bundled and dressed to the termination
    blocks. All appropriate cable management materials (slotted duct, D rings, etc.)
    should be utilized for this purpose.

g. All station cabling shall be clearly and legibly labeled at both the faceplate end
    and the MDF termination blocks. In addition to labeling both the inside of the
    faceplates and MDF termination blocks, the cable jacket shall be labeled six inches
    back from the terminations on both ends. Labeling shall be indelible.

h. Labeling of the outside of the jack with identification numbers shall be made using
    a Brother “P” touch system or equal. Samples shall be provided to Engineer for
    approval prior to installation.

i. License Classification: Contractor must posses a valid state Contractor’s License.

1.5 SYSTEM DESCRIPTION

A. The data communications system shall consist of two components, active switch equipment and
   twisted pair copper work station cabling (voice and data).

1.6 SCOPE OF WORK

A. Contractor shall provide materials for and install a complete, functional voice/contract data
   communications system and video system in accordance with this specification and the
   drawings. Contractor shall be responsible for providing a complete, functional system including
   all necessary components, whether included in this specification or not.

B. The installation shall include cable (twisted-pair copper), innerduct, interconnect/patching
   equipment (copper), connectors (copper), jumpers (twisted-pair copper), wiring blocks, and
   telecommunications outlets, and any other equipment. In addition to material and equipment,
   Contractor shall provide labor and any incidental material required for installation. All copper
   station cables shall be terminated on patch panels and data communications outlets. Upon
   completion of installation, Contractor shall test all copper pathways and record the test results,
   as specified in the following.

C. The work performed under this specification shall be of good quality and performed in a
   workmanlike manner. In this context “good quality” means the work shall meet industry
   technical standards and quality of appearance. The owner reserves the right to reject all or a
   portion of the work performed, either on technical or aesthetic grounds.
1.7 ALTERNATES

A. Include separate pricing for amounts to be added to or deducted from base bid amount as outlined in bid form.
   1. None.

1.8 PROTECTION OF WORK AND PROPERTY

A. Be responsible for the care and protection of all work included under this Section until it has been tested and accepted.

B. Protect all equipment and materials from damage from all causes including theft. All materials and equipment damaged or stolen shall be replaced with equal material or equipment at the option of the Architect and Owner.

C. Materials and equipment stored for this project shall be protected and maintained according to the manufacturer's recommendations and requirements and according to the applicable requirements of NFPA 70B.

D. Protect all equipment, outlets and openings with temporary plugs, caps and covers. Protect work and materials of other trades from damage that might be caused by work or workmen and make good any damage caused.

E. Observe all safety precautions and requirements for the construction.

F. The General Contractor and the Installer are responsible for initiating, maintaining, and supervising all safety precautions and requirements during construction.

1.9 MAINTENANCE

A. Upon receipt of notice from the Owner of failure of any part of the systems during the warranty period, the affected parts shall be replaced. Any equipment requiring excessive service consisting of more than two unscheduled service calls, shall be considered defective and shall be replaced.
   1. Response times to warranty issues shall differ according to the level of the problem.
   2. A problem is considered to be corrected when the system and its components operate according to specified requirements.
   3. Warranty work shall be performed according to the procedures of the Owner, its staff and tenants and their normal operations.

1.10 FUNCTION AND OPERATION

A. The intended function of the data communications cable system is to transmit data signals from a central location to several individual data outlet locations. Upon completion of the work outlined in this specification, the system shall be capable of transmitting data signals at a rate of 1000 Mbps.

B. Work station cable shall be installed in accordance with EIA/TIA-568-A specified installation practices, EIA/TIA TSB 67 recommended installation practices, manufacturer specified installation practices, and shall be capable of transmitting a signal at 1000 Mbps with acceptable attenuation and cross-talk measurements. The entire work station cable system, including wiring blocks, cable, and telecommunications outlets shall be tested for Category 6 compliance.
1.11 RETURN AIR PLENUM

A. All wiring systems, including telephone and/or data shall be plenum rated.

PART 2 - PRODUCTS

2.1 GENERAL

A. Throughout Part 2, material quantities are given. These quantities are given for reference purposes only. It is the responsibility of the Contractor to provide appropriate quantities of materials to provide a complete, functional system.

B. All interconnectivity devices racks, patch panels, jacks and faceplates, etc. shall be manufactured by Ortronics, Hubbell, Panduit, or equal

C. Equipment shall be installed in accordance with Technology drawings. General installation provisions are as follows:

1. Equipment Racks: Equipment racks shall be assembled and mounted in locations shown in the Drawings and as described herein. Each rack shall be assembled in accordance with the manufacturer's instructions and recommendations. Each rack shall be mounted such that the side rails are plumb. Each rack shall be affixed to the building structure at each of the mounting holes provided. Attachment shall be by 1/2" X 1-1/4" lag bolts. A 3/8" pilot hole shall be drilled for each lag bolt. Each bolt shall be tightened to the extent that it holds the mounting hardware firmly, but not so tight as to distort the hardware or strip the threads. Equipment racks are to be co-located with the quadplex power outlets to allow for easy connection of racked equipment to the power system of the school.

2. Wiring Blocks and Wire Management Components: Where required, wiring blocks and wire management components shall be mounted to the plywood backboard. Wiring blocks and wire management shall be mounted in accordance with the attached drawings. Each device shall be mounted such that its horizontal dimension is level. In cases where more than one device is mounted, they shall be aligned vertically. Each device shall be affixed to the plywood backboard by means of screws suitable for fastening to plywood. A minimum of four (4) of the mounting holes provided shall be utilized for fastening. Screws shall be tightened to the extent that they hold the device snug to the backboard, but not so tight as to distort or damage the device. Wiring blocks shall be terminated in accordance with the manufacturer's instructions and recommendations. Installation of accessories shall also be conducted in accordance with the manufacturer's instructions and recommendations.

3. Technical Requirements: Horizontal cabling: the horizontal subsystem is the portion of the telecommunications cabling system that extends from the work area telecommunications outlet/connector to the horizontal cross-connect in the Telecommunications room/closet. It consists of the telecommunications outlet/connector, the horizontal cables, optional consolidation point, and that portion of the cross-connect in the telecommunications room/closet serving the horizontal cable. Each floor of a building should be served by its own horizontal subsystem.

a. Cable Types: All UTP and fiber optic cables shall conform to ANSI/TIA/EIA-568-B1, B2, B3 Commercial Building Telecommunications Cabling Standard (latest amendment and including all applicable addenda) and ISO/IEC 11801 (International) Generic Cabling for Customer Premises standard (latest amendment and including all applicable addenda).
D. DESCRIPTION: From each IDF, 4-pair enhanced Category 6A cables shall be routed to each work station (data outlets). Category 6A shall be installed for wireless access node outlets per Technology Drawings.

1. Product:
   a. Copper 4-pair UTP:
      a) UTP cables shall be manufactured by one of the following:
         - Hitachi Cable Manchester
         - Berk-Tek
         - Commscope
         - General Cable
         - Mohawk
         - Or equal

2. Required Accessories and Quantities (Hard Wall Locations):
   a. Work Station: shall be metal with ivory or white finish (refer to drawings), Single Gang, Single Port Face plate. Using Panduit CMB**-X blank modules to fill unused ports. Refer to drawings for two, three, and four gang configurations. Modules shall be CJ688TP** – color to be selected by engineer.

3. Work Area Equipment Cords: The Work Area Equipment Cords shall meet or exceed the following criteria:
   a. Modular Equipment Cords: Category 6A cable

4. Category 6A, modular equipment cords shall:
   a. Be round, and consist of eight insulated 24 AWG, stranded copper conductors, arranged in four color-coded twisted-pairs within a flame-retardant jacket.
   b. Be equipped with modular 8-position (RJ45 style) plugs on both ends, wired straight-through with standards compliant wiring.

5. Use modular plugs which exceed FCC CFR 47 part 68 subpart F and IEC 60603-7 specifications, and have 50 micro-inches minimum of gold plating over nickel contacts.

6. Be resistant to corrosion from humidity, extreme temperatures, and airborne contaminants.

7. Utilize cable that exhibit power sum NEXT performance.
   a. Be available in several colors with or without color strain relief boots featuring a snagless design.
   b. Provide one 10 foot cord per data jack shown on drawings.
   c. Be made by an ISO 9001 and 14001 Certified Manufacturer.
   d. Electrical Specifications:
      e. DC resistance per lead: 9.38 Ω / 100 m maximum.
      f. Input impedance without averaging: 100 Ω + 15 percent from 1 to 100 MHz.
      g. 100 percent transmission tested with laboratory grade network analyzers for proper performance up to 1000 MHz. Vendor shall guarantee cords are compatible with category 6A links/3A links.

8. UL VERIFIED (or equivalent) for TIA/EIA proposed category 6A electrical performance.

9. UL LISTED 1863.

10. All information outlets for 100 Ω 22-26 AWG copper cable shall:
    a. Be available in black, white, gray, ivory and light ivory.
    b. Accommodate a minimum of two 8-position / 8-conductor modular jacks.
    c. Utilize compliant pin technology 110 style insulation displacement connectors which allows the use of a 4-pair impact tool.
    d. Allow for a minimum of 200 re-terminations without signal degradation below standards compliance limit.
    e. Be constructed of high impact, flame-retardant thermoplastic.
    f. Be available in a screened version for 100 Ω ScTP cable.
    g. Be made by an ISO 9001 and 14001 Certified Manufacturer.
    h. Electrical Specifications:
i. ANSI/TIA/EIA-568-B1, B2, B3 and ISO/IEC 11801 proposed category 6A compliant.

E. INSTALLATION: Installation shall be conducted in accordance with guidelines established the manufacturer and industry standards. Wall Plates shall be mounted such that their vertical dimension is plumb. Each wall plate shall be labeled with its respective work station number. Each modular mounting frame shall be labeled with its respective work station number.

2.2 INTERMEDIATE DISTRIBUTION FACILITY (IDF)

A. DESCRIPTION: The equipment shall be installed in accordance with Drawings.

1. Products and Quantities:
   b. Fiber Interconnect: Panduit FRME24 rack mount fiber optic enclosure. Supply and install as many as necessary to service all fiber strands entering the MC.
   c. Modular Patch Panels: Panduit CPPLA48WBLY: 48-port angled Category 6A Patch Panel. One (1) Port for each workstation served from the MDF with a minimum of 12 spare ports are required. If the number of workstation cables, plus required spare count (12) is greater than 48, then a second 48-port patch panel is required. Supply and install as many patch panels in the MDF as necessary to service all workstation cables plus the required spare count.
   d. Patch Cables: Panduit UTPSPXX-** where XX is the length in feet and ** is the color. The length shall vary between 3’ and 15’ and shall be determined by Owner.

2. Required Accessories and Quantities:
   b. Fiber Jumpers: Panduit F92ELQ1Q1SMN003, 3 meter, singlemode Duplex, OS1/OS2, LC to LC Fiber Jumper.
   c. Wire Management: Panduit WMPH2E Front/Rear cable manager or Panduit WMPLSE Low Profile Cable Manager.
   d. Cable Management Rings and Strain Relief: Panduit CMVDR1 2”x5” Vertical Manager Ring, Panduit WMBV2 2”x5” Vertical Manager Ring and/or Panduit WMSRC1 or WMSRC2 strain relief clips. Provide and install sufficient quantities to conform to attached Drawings.

B. INSTALLATION: Installation shall be conducted in accordance with manufacturer's recommendations, industry standards, and this specification. Installation includes complete assembly and mounting of the fiber interconnect equipment, dressing the fiber and copper cables, complete assembly and mounting of the equipment rack, and mounting of the wiring blocks. Equipment shall be mounted in accordance with attached Drawings.

2.3 TESTING AND DOCUMENTATION

A. TESTING: Contractor shall test each fiber strand and each pair of each twisted-pair copper cable. The Owner reserves the right to have a representative present during all or a portion of the testing process. If the Owner elects to be present during testing, test results will only be acceptable when conducted in the presence of the Owner.

1. Workstation Cable: Each workstation cable shall be tested from the Jack Panel to the data outlet.
   a. Test Equipment: Class II Category 6 Field.
   c. Test Criteria: The system shall be tested to Category 6 Level II compliance. The test path shall include workstation jacks, station cables, jack panels, and adapter cables.
B. DOCUMENTATION: Contractor shall provide documentation to include test results and as-built drawings.
   1. Work Station Cable: The results of the work station cable tests shall be provided in the form of print-outs from the test equipment.

2.4 TELEPHONE SYSTEM
A. Install a system of telephone outlet terminals, cable and the associated labor and miscellaneous and materials to provide a telephone system. Telephone equipment shall be furnished & installed by the owner’s telephone equipment vendor. All work shall be installed in accordance with the requirements of the telephone system vendor and as indicated on the Drawings. Telephone system will be VOIP and utilize same network as data equipment.

PART 3 - EXECUTION

3.1 GENERAL
A. Submittals:
   1. Data sheets shall be provided on all equipment being provided.
   2. Internal control cabinet Drawings showing internal block diagram connection shall be provided.
   3. Wiring diagrams showing complete field wiring requirements shall be provided.
   4. FCC registration numbers shall be provided.

B. Maintenance Service:
   1. The Contractor shall provide a one-year guarantee of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner. Guarantee period shall begin on the date of acceptance by the Owner.
   2. A maintenance contract offering continued factory authorized service of this system shall be made available to the Owner after the first year warranty period.

C. Quality Assurance
   1. The vendor shall be an authorized distributor of the supplied equipment with full warranty privileges.
   2. The vendor shall maintain at his facility the necessary spare parts in the proper proportion as recommended by the equipment manufacturer to maintain and service the equipment being supplied.
   3. The vendor shall have attended the manufacturer's installation and service school.
   4. The vendor shall furnish manufacturer's manuals of the complete system including individual Specification sheets, schematics, inter-panel and intra-panel wiring diagrams. In addition, all information necessary for the proper maintenance and operation of the system must be included.
   5. As-Built Drawings that include any changes to wiring, wiring designations, junction box labeling and any other pertinent information shall be supplied upon completion of project.

D. Check out and final connection to the system shall be made by a factory trained technician in the employ of a manufacturer of the products installed. In addition, factory trained technicians shall demonstrate operation of the complete system and each major component to the Owner.

E. Upon completion of the installation, 3 copies of complete operational instructions shall be furnished, complete with Record Drawings, 1/16” scale minimum. Instructions shall include part numbers and names, addresses, and telephone numbers of parts source.
F. Upon completion of the installation of the equipment, The Contractor shall provide to the Engineer a signed statement from the equipment supplier that the system has been wired, tested, and function properly according to the Specifications.

G. Service Training

1. The vendor shall furnish 8 hours of in-service training with the system.
2. These sessions shall be broken into segments that will facilitate the training of individual operating station equipment, administrative devices, user programming functions, and program distribution equipment. Operating manuals and user guides shall be provided at the time of the training.
3. These sessions shall be video-taped by the vendor, with one copy of the tapes provided to the Owner.

END OF SECTION
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SECTION 280000
ELECTRONIC SECURITY SYSTEM

PART 1 - GENERAL

1.1 FILED SUB-SUB BIDS

A. Section 270000 TECHNOLOGY shall be a Filed Sub-Sub Bid of Section 16000, requiring a Paragraph “E” Listing on the FORM FOR SUB-BID.

B. Work included under this SECTION is shown on all Drawings. Examine all drawings for requirements affecting the work of this Section.

C. The DCAM category that this Contractor shall be certified is: Telecommunications Systems.

1.2 GENERAL PROVISIONS

A. The General Conditions, Supplementary General Conditions and General Requirements shall be included in and made a part of this Section.

B. Examine all Drawings and other Sections of the Specification for requirements affecting the Work of this Section.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 260000 – Electrical General Provisions

B. Section 260000 – Basic Materials and Methods

1.4 EXAMINATION OF SITE AND DOCUMENTS

A. Vendors/Contractors are expected to examine and to be thoroughly familiar with all contract documents and with the conditions under which work will be carried out. The Awarding Authority (Owner) will not be responsible for errors, omissions and/or charges for extra work arising from IESS Vendor/Contractor failure to familiarize themselves with the Contract Documents or existing conditions. By submitting a quote, the Vendor/Contractor agrees and warrants that he has had the opportunity to examine the site and the Contract Documents, that he is familiar with the conditions and requirements of both and where they require, in any part of the work a given result to be produced, that the Contract Documents are adequate and that he will produce the required results.

B. Proprietary System:

1. Security System is a proprietary item as determined by the City and shall be manufactured by Genetec, as the system is an extension to the existing system to remain. The intrusion system is existing NAPCO Magnum and shall remain. Intrusion system shall be extended/modified.
1.5 OVERVIEW

A. The Integrated Security System consists of the following subsystems. All systems referenced below shall be connected to a stand-alone, dedicated security network as provided by the security contractor.

1. Access Control Platform (Genetec)
2. Genetec Omnicast System Extension
3. NAPCO Magnum intrusion system.

1.6 QUALIFICATIONS

A. The Systems Integrator shall be experienced in the operations they are engaged to perform.

1.7 SUBMITTALS

A. General: Submit the following according to the Conditions of Contract and Division 01 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.
3. Table of contents with page numbering.
4. Wiring diagrams from manufacturer.
5. A sequence of operation for the system and each sub-system shall be provided.
7. Provide system details including location of all devices and circuiting. Provide point to point diagrams with all accessory equipment shown.
8. Operation and maintenance data for inclusion in Operating and Maintenance Manual. Include data for each type product, including all features and operation sequences, both automatic and manual. Provide the names, addresses and telephone numbers of service organizations.

PART 2 - PRODUCTS

2.1 SYSTEM CABLEING

A. Provide and terminate all cabling per manufacturers recommendations for a completely operational system as specified.

B. Cabling for Access Control System, provide & terminate all cabling as required for a completely operational Access Control System as required by equipment manufacturer.

1. EL = Door Lock Device; provide & terminate cabling between EL and associated Power Supply and between Power Supply and associated ACC. Electrical Sub-contractor shall confirm power supply location with installer. Electrical Sub-contractor shall provide 120VAC outlet and power supply backbox at power supply location. EL furnished and installed by door hardware, associated centralized EL Power Supply furnished, installed, and wired by systems integrator. EL may be an Electronic Door Strike, Magnetic Door Lock, etc., see Architect for details.
2. CR = Door Reader Device; provide CR, provide and terminate cabling to associated ACC. The cable requirements of the card reader shall be a minimum five (5) conductor, 22 AWG, stranded cable with overall shield (for a Wiegand protocol interface). A six (6) conductor cable is required when controlling the red and green LED individually. A seven (7) conductor cable is required when both the red and green LED’s are controlled by the Host. A 22 AWG twisted pair, shielded, stranded cable is required for use of the tamper switch. The card reader shall be provided with a 10 wire pigtail connector.

3. ALM = Alarm Line Module; provide ALM, provide & terminate cabling to associated Door Contact, and ACC. ALM mounts within J-Box at door location.

4. DC = Door Contacts (recessed in door/frame); DC furnished, installed and wired by systems integrator, provide & terminate cabling to associated ALM (Alarm Line Module).

5. ACC = Access Control System Controller.

6. ACS = PC & Monitor for Access Control System.

2.2 UNIFIED SECURITY PLATFORM (EXISTING)

A. General

1. The United Security Platform is defined as the Unified software package used for the Access Control systems.

2. The Unified Security Platform (USP) shall be extended to include the doors for the Fire Station at Taylor Square. Software is existing on server. Provide all required programming to include new doors at Fire Station.

3. Manufacturer (Proprietary)

   a. Security Center platform as manufactured by Genetec.

2.3 HARDWARE AND PERIPHERALS

A. Reader and Input/Output (I/O) Control Panels

1. General

   a. The control panels include but no limited to card reader modules, input modules, output modules, power supply, harnesses, and batteries. Provide quantities as required for a complete working system. Each module card shall be neatly installed in a locked wall cabinet. Enclosures shall be located in each IDF/MDF or as shown on the drawings. Each controller shall be connected to the security network switch. Provide Hoffman enclosures or approved equal.

2. Features

   a. Stores a complete access control and configuration database for up to 32 Reader Interfaces (up to 64 doors) and 44,000 cardholders with expansion capability up to 250,000 cardholders.

   b. The access control system interfaces with combinations of devices with a maximum of: 32 Door/Reader interfaces (up to 64 doors/readers) or 32 input monitor interfaces (up to 512 monitor points) or 32 output control interfaces (up to 384 control relays)

   c. Reports supervised inputs/alarms with 255 priorities.

   d. Includes an HTTP API, Windows® DLL API, and direct communication API.

   e. Allows local connection of a laptop computer for diagnostics and configuration.

   f. Connects to the host and other devices on a TCP/IP network.

   g. Receives and processes real time commands from the host software application.

   h. Reports all activity to the host.

   i. Controls and communicates with all connected devices.
j. Buffers offline transactions and uploads to the host when communication is restored.
k. UL 294 and UL 1076 recognized component.

3. Provide HID to match existing. Provide with wall mounted cabinet and locking front door equal to Hoffman.

B. Combination Card Reader and Keypad

1. Provide contactless multi-class readers with keypad as shown on the drawings.
2. Each reader shall operate on a 13.56MHz and 125kHz transmit frequencies.
3. The reader shall have a Weigand output.
4. The readers shall have both an audio and visual notification for access granted and access denied.
5. The reader shall be suitable for indoor and outdoor applications.
6. The reader shall operate up to 500ft on 22AWG cable.
7. The reader shall be able to communicate with either 2K, 16K or 32K bit iClass cards.
8. Reader shall have and/or functionality for the keypad and/or the proximity reader to allow access.
9. Provide HID multiClass readers to match existing or approved equal.

C. Request-to-exit devices

1. Furnish and install motion request-to-exit sensors as shown on the drawings and as required. Devices shall mount directly above the each door. Utilize doors that have hardware which have integral request-to-exit switches as required. Coordinate with door hardware.
2. Provide DS 150i or approved equal with trim plate.

D. Auxiliary Power Supply

1. Provide auxiliary power supply(s) for REX sensors, microphones, etc as required. Provide Altronix or approved equal.

E. Magnetic locks power Supply

1. Furnished by others, wired by Security Contractor.

F. Locking Devices (Electric strike/Magnetic locks/Electric locks/Electric Hinges)

1. Furnished and installed by others. Wired by security contractor.

G. Central Access Door Power Supply

1. Provide Altronix Maximal 77D Access Power Controller
2. Input:
   a. 115VAC 60Hz, 8.8 amp input.
   b. Power supply input options:
      1) Two (2) common power inputs for either ACM8CB and lock power (factory installed).
      2) Two (2) isolated power inputs (external power supply is required). Current is determined by the power supply connected, not to exceed a maximum of 10 amp total.
d. Input options:
   1) Sixteen (16) normally open (NO) inputs.
   2) Sixteen (16) open collector inputs.
   3) Any combination of the above.

3. Output:
   a. 24VDC outputs.
   b. Maximum output current:

<table>
<thead>
<tr>
<th>Options</th>
<th>P/S 1</th>
<th>P/S 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>24VDC @ 9.7 amp</td>
<td>24VDC @ 9.7 amp</td>
</tr>
</tbody>
</table>

c. Class 2 Rated power-limited outputs.

d. Sixteen (16) independently controlled outputs can be Fail-Safe and/or Fail-Secure power outputs.

e. Sixteen (16) auxiliary power outputs (unswitched) (outputs are rated 2 amp).

f. Filtered and electronically regulated outputs (built-in power supply).

g. Thermal and short circuit protection with auto reset.

4. Fuse Ratings:
   a. Power Supply input fuse rated @ 10 amp/250V.
   b. ACM8CB boards main fuse is rated at 10 amp. Output fuses are rated @2.5 amp.

5. Features:
   a. Fire Alarm disconnect (latching or non-latching) is individually selectable for any or all of the sixteen (16) outputs.
   b. Fire Alarm disconnect input options:
      1) Normally open (NO) or normally closed (NC) dry contact input.
      2) Polarity reversal input from FACP signaling circuit.
   c. Alarm output relay indicates that FACP input is triggered (form “C” contact rated @ 1 amp 28VDC).

6. Supervision:
   a. AC fail supervision (form “C” contacts).
      1) Notification trigger is selectable for 30 seconds (factory set) or 6 hours.
   b. Low battery and battery presence supervision (form “C” contact).

7. Battery Backup:
   a. Built-in charger for sealed lead acid or gel type batteries.
   b. Maximum charge current 3.6 amp per p/s board.
   c. Automatic switch over to stand-by battery when AC fails.
   d. Zero voltage drop when unit switches over to battery backup (AC failure condition).

8. Visual Indicators:
   a. Red LEDs indicate outputs are triggered (relays energized).
   b. Green LED indicates FACP disconnect is triggered.
   c. AC input and DC output LED indicators.
9. Electrical:
   a. Operating temperature: 0º C to 49º C ambient.
   b. BTU/Hr.: 238.3 BTU/Hr.
   c. System AC input VA requirement: 1012VA.

10. Mechanical:
    a. Enclosure Dimensions (H x W x D approx.): 26" x 19" x 6.25" (660.4mm x 482.6mm x 158.75mm)
    b. Enclosure accommodates up to four (4) 12AH batteries.
    c. Product weight (approx.): 43.3 lbs. (19.64 kg).
    d. Shipping weight (approx.): 47.3 lbs. (21.45 kg).

H. Integrated Communication And Door System

1. General
   a. Section Includes:
      1) The system is a proprietary item as determined by the City and shall be manufactured by Aiphone IS Series IP Security Intercom, or equal.

   b. References

   c. System Description
      1) General: Video security communication system.
         a) Installed separately from conventional general-purpose internal communications systems, the IS system shall be used as a video door entry system, emergency announcement system, rescue assistance system, urgent call system, public announcement system, and access control system as scheduled, indicated or required.
         b) The system shall be comprised of multiple control units and/or IP direct masters and video door stations. Sub stations shall be installed in multiple locations as scheduled, indicated or required for complete installation.
         c) The control unit shall have an add-on feature that permits customization by plugging in additional control units directly or through the network.
         d) A full range of control unit functions, including basic conversation, shall be capable: call forwarding, scan monitoring, emergency call, priority call, video audio recording, paging, and zone paging as scheduled, indicated or required.
         e) Types of sub stations: vandal resistant, handset indoor use, flush mount, and surface mount types as scheduled, indicated or required.
         f) The IS system shall be used in combination with CCTV, access control, an emergency broadcast system, scheduled chime distribution system, or other security equipment. This creates a more effective security communication system and ensures a higher level of safety, security, and convenience in each application.

   d. System Capacity: Refer to schedule and drawings for required components.
1) IP System:
   a) 1028 IP units per system (IS-IPC, IS-IPMV, IS-IPDV, IS-IPDVF, and PC master station (IS-SOFT)) Maximum 32 IP devices, including a Maximum of 8 IS-IPC per site. Maximum 32 sites.
   b) 5120 Master stations.
   c) 5120 Video Door stations.
   d) 30720 Audio or room sub stations.
   e) 7168 paging outputs.
   f) 512 Chime source inputs.
   g) 256 Telephone outputs. Maximum 1 per IS-IPC.

e. System Capability:
   1) Video, Audio, and Data Logging:
      a) PC archives.
      b) Record video and audio from door stations.
   2) Master Station Flexibility:
      a) Pan-tilt zoom and wide video monitoring function.
      b) Master station with 3.5 inch display for operation and video monitoring.
      c) Hands-free or handset audio communication.
   3) Outside Line Communication:
      a) One telephone line, call transfer to up to three telephone numbers.
      b) Door and room sub stations to outside telephone line communication.
   4) Internal Audio file for prerecorded message announcement or notification:
      a) Up to 15 audio files can be uploaded to the system.
      b) Up to 20 sequences per day for scheduled announcement.
   5) External Audio Input:
      a) Multiple activation inputs with 2 audio inputs for external source distribution.
   6) Audio Distribution Scheduling:
      a) Up to 1 year scheduling for calendar schedule.
      b) Up to 20 daily events can be programmed.
      c) Individual scheduled activation can also be set one time or daily.

f. System Functions:
   1) Call-Related Functions:
      a) Video Door Station Call: A designated group of up to 20 master stations can be called from any video door station; any designated master can answer the call. 170 degrees’ view from the door station camera can be viewed from the master station, and zoom and pan/tilt operations are functional.
      b) Sub Station Call: A designated group of up to 20 master stations can be called from any substation; any designated master can answer the call. External speaker and emergency call button can also be added.
      c) Group Call/All Call: A designated group of up to the full capacity of the system with any mix of master stations and door stations can be called from a master station. System needs to be pre-programmed to function.
   2) Transfer-Related Function:
      a) Call (Communication) Transfer: A master station can transfer a conversation to any master station within the system.
   3) Call Forwarding-Related Functions:
      a) Call Forwarding: Incoming calls can be automatically forwarded to another receiving station or telephone. The receiving station number or telephone number can be registered at the original forwarding station. Unit number will be assigned to each telephone number.
b) Time-Based Call Forwarding: All incoming calls to the original station can be automatically rerouted to a designated master station or telephone number during a specific period of the day.

c) No Answer Call Forwarding: Calls to the original station are automatically rerouted to a designated receiving station if the called party does not respond within a preset period of time.

4) Monitoring-Related Functions:
   a) Monitoring: Any door, room or substation can be monitored from a master station. A master station can also disable this function if monitoring is not necessary.
   b) Scan Monitoring: Any pre-programmed door stations or room sub stations (Maximum 20) can be scan monitored.

5) Paging-Related Functions:
   a) Zone Paging: Permits paging to up to 99 individual zones (01-99), established by combining multiple master stations, door stations, and room sub stations with or without public address system equipment. Up to five zones can simultaneously be selected.
   b) Pre-Recorded Audio File Paging: Pre-recorded audio file or outside sound sources can be distributed to pre-programmed paging zones.

6) Priority Call-Related Functions:
   a) Priority Call: Any call from the master station or substation can be pre-programmed with priority level based on normal call, priority call, and urgent call. Urgent call will have the highest priority within individual calls.
   b) Emergency Paging: Emergency paging calls can be made to pre-programmed paging zones. Emergency paging will have the highest priority level. Paging can also be pre-programmed with priority level based on normal call, priority call, and urgent call. Urgent call will have the highest priority.

7) Telephone-Related Functions:
   a) Outgoing Telephone Calls: Outside telephone lines can be connected to the IS system, permitting calls from room subs and doors to be forwarded to an outside telephone line.
   b) Pre-Recorded Audio File Paging Via Telephone: Pre-recorded audio file can be distributed to programmed paging zones or stations via the telephone.
   c) Time-Based Outside Line Call Forwarding: Three telephone numbers can be pre-programmed to be forwarded if the called party does not respond within a preset period of time.

8) Scheduled Pre-Recorded Audio File Paging:
   a) Scheduled Paging and Bell: Paging or bell schedules can be programmed onto daily, weekly or yearly calendar.

9) Submittals
   a) Submit under provisions of Part 1 Submittals Section.
   b) Product Data: Manufacturer's data sheets on each product to be used, including:
      • Preparation instructions and recommendations.
      • Storage and handling requirements and recommendations.
      • Installation methods.

10) Shop Drawings: Submit the following:
    a) Wiring Diagrams: Indicate wiring for each item of equipment and interconnections between items of equipment.
    b) Include manufacturer's names, model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
11) Installation and Operation Manuals:
   a) Submit manufacturer's installation and operation manual, including operation instructions and component wiring diagrams.
   b) Provide detailed information required for Owner to properly operate equipment.

12) Warranty: Submit manufacturer's standard warranty.

13) Quality Assurance
   b) Installer Qualifications: Minimum 2 years’ experience installing similar equipment and manufacturer's certification is recommended.

g. Delivery, Storage, and Handling
   1) Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
   2) Storage: Store materials in clean, dry area indoors in accordance with manufacturer's instructions.
   3) Handling: Protect materials during handling and installation to prevent damage.

h. Project Conditions
   1) Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

2. Products
   a. Security and communication system.
      1) System Environment:
         a) A PC is required to configure the system.
         b) Operating System: *Windows 7, 8, 8.1, and 10.
         c) For the IP system, an internet broadband connection is required and routers require Static Global IP Address.
         d) A supported router is required when connected to the Internet.
         e) Depending on the network environment or the computer's performance, operations may not be carried out normally. Examples include interrupted audio and/or video, or a delayed frame rate.
         f) Depending on the network environment, the operation may become invalid when operating systems in succession.
         g) The IP system can input chimes from one IS-CCU.
         h) The IP system can only input chimes from the host IP control unit and one IS-CCU can be used.
         i) The number of calls via IP network corresponds with the number of IP talk channels.
         j) Even when all talk channels are occupied in the Local (Analog) system, an incoming call will be announced by tone and LED, but communication cannot begin until a talk channel is opened in the local system. If all video channels are occupied, master stations will be able to communicate, but no video will be displayed.
         k) Only a single site can be called at a time.
         l) Use of a wireless LAN is not recommended, as it may cause improper operation and latency problems due to security configuration.
m) System functionality is dependent on availability of the network. Depending on the network environment and computer, the system may not be usable.

b. Components
1) Control Unit:
a) Product: IS-IPC IP Control Unit.
   • Power Source: 48V DC (supplied from power supply unit)
   • Current Consumption: Maximum 105mA
   • Talk Channels/Video Channels/Other Channels: Standard (IP) system: 2 talk and 2 constrained video channels, 1 chime, and 1 telephone (North America only).
   • Central Control Unit: Maximum 1.
   • Room Sub Control Unit: Maximum 1.
   • Setting LAN: Ethernet (10 BASE-T, 100 BASE-TX)
   • Mounting: Rack-mount (19-inch, 2U rack).
   • Mounting: Wall mount.
   • Ambient Temperature: 0 - 40 degrees C (+32 degrees F - +104 degrees F).
   • Material: Steel plate.
   • Color: Black.

b) Product: IS-CCU Central Control Unit.
   • Power Source: 48V DC (supplied from Power supply unit).
   • Current Consumption: Maximum 800 mA.
   • Master Stations: Maximum 4.
   • Video Door Stations/ Audio Door Stations/ Room Sub Stations: Maximum 4.
   • Add-on Control Unit: Maximum 2.
   • Room Sub Control Unit: Maximum 4.
   • IP Control Unit: Maximum 1.
   • Video Output: NTSC and BNC (Video channel 1,2).
   • Setting LAN: Ethernet (10 BASE-T).
   • Talk Channels / Video Channels: Local system: 2 talk and 2 video channels, 1 chime.
   • Mounting: Rack-mount (19-inch, 2U rack).
   • Mounting: Wall mount.
   • Ambient Temperature: 0 to 40 degrees C (+32 degrees F to +104 degrees F).
   • Material: Steel plate.
   • Color: Black.

c) Product: IS-SCU Add-on Control Unit.
   • Power Source: 48V DC (supplied from Power supply unit).
   • Current Consumption: Maximum 1.2 A.
   • Talk Channels / Video channels: Local system: 2 talk and 2 video channels, 1 chime.
   • Master Stations: Maximum 8.
   • Video Door Stations/ Audio door stations/ Room substations: Maximum 8.
   • Video output: NTSC and BNC (Video channel 1,2).
   • Mounting: Rack-mount (19-inch, 2U rack).
   • Mounting: Wall mount.
   • Ambient Temperature: 0 to 40 degrees C (+32 degrees F to +104 degrees F).
   • Material: Steel plate.
   • Color: Black.
d) Product: IS-RCU Room Sub Control Unit.
   • Power Source: 48V DC (supplied from Power supply unit).
   • Current Consumption: Maximum 1.8 A.
   • Talk Channels: Local system: 2 talk, 1 chime.
   • Audio Door Stations: Maximum 30.
   • Mounting: Rack-mount (19-inch, 2U rack).
   • Mounting: Wall mount.
   • Ambient Temperature: 0 to 40 degrees C (+32 degrees F to +104 degrees F).
   • Material: Steel plate.
   • Color: Black.

  c. Color Monitor Master Station:
   1) Product: Color monitor IP master station (IS-IPMV).
      a) Power Source: 48V DC (PoE).
         • Current Consumption: Maximum 65 mA.
      b) Power Source: 24V DC (supplied from the power supply unit).
         • Current Consumption: Maximum 130 mA.
      c) Communication:
         • Handset: Simultaneous communication (When press-to-talk (PTT) is not set)
         • Hands-free: Auto-voice actuation or Press-to-talk (PTT).
      d) Monitor: 3.5 inch (89 mm) color LCD monitor.
      e) Call Record: 20.
      f) Reception Record: 20.
      g) Paging Capacity: Simultaneous paging to Maximum 5 zones/stations.
      h) Mounting: Desktop use, with stand.
      i) Mounting: Wall mount, without stand.
      j) Ambient Temperature: 0 - 40 degrees C (+32 degrees F - +104 degrees F).
      k) Electrical Box: 1 gang box, for wiring only, unit fixed to the wall directly.
      l) Electrical Box: 3 gang box, for wiring and fixing the unit.
      m) Material: Flame resisting ABS resin.
      n) Color: Black.

   2) Product: IS-IP4DVF IP vandal-resistant video door station with (4) call buttons (flush-mount).
      a) Power Source: 48V DC (PoE).
         • Current Consumption: Maximum 85 mA.
      b) Power Source: 24V DC (supplied from the power supply unit).
         • Current Consumption: Maximum 160 mA.
      c) Communication: Open voice hands-free communication.
      d) Ambient Temperature: -10 - 60 degrees C (+14 degrees F - +140 degrees F).
      e) Camera: 1/4-inch (6 mm) color CMOS.
      f) Minimum Illumination: 5 Lux.
      g) Camera Angle: Wide, approximately 170 degrees (horizontal).
      h) Mounting: Flush-mount.
      i) Electrical Box: Not used, mounts on built-in back box.
      j) Front Panel: Stainless steel, vertical hair-line processed.
      k) Main Unit: Flame resisting PC+ABS resin.
      l) Color, Back box: Black.
      m) Service: Weather-resistant.
      n) Four Call Buttons
      o) Provide IS-IPRY8 for each IS-IP4DVF
   a) Power Source: DC Supplied from Central control unit or Add-on control
      unit or Room sub control unit.
   b) Communication: Open voice hands-free communication.
   c) Ambient Temperature: -10 to 60 degrees C (+14 degrees F to +140
      degrees F).
   d) Mounting: Flush mount to 2-gang box.
   e) Electrical Box: 2-gang box.
   g) Main Unit: Flame resisting PC and ABS resin.
   h) Front Panel: Silver (stainless steel, vertical hair-line processed),
   i) Description: Weather-resistant, for indoor or outdoor use.

4) Product: IS-RS Room Sub Station.
   a) Power Source: DC Supplied from Central control unit or Add-on control
   b) Communication:
      • Handset: Simultaneous Communication (when press-to-talk
        (PTT) is not set).
      • Hands-free: Auto-voice actuation or Press-to-talk (PTT).
   c) Ambient Temperature: 0 to 40 degrees C (+32 degrees F to +104
      degrees F).
   d) Mounting: Surface wall mount (Directly to wall).
   e) Electrical box: Single-gang box.
   f) Housing: Flame resisting ABS resin.
   g) Color: Black.

5) Product: IS-HTR Heater and Thermostat for IS Series Door Stations
   (excluding IS-SS-2G).
   a) Ambient Temperature: -40 to 60 degrees C (-40 degrees F to +140
      degrees F).
   b) Heater Element: 23.04 ohms, resistive, non-inductive pattern; 25 watts
      (REF) at 24V, thermostatically controlled.
   c) Thermostat Activation: On at 15 degrees C (59 degrees F), off at 25
      degrees C (77 degrees F).
   d) Power: 24V AC/DC.

   a) Color: Black.
   b) Material: Aluminum.

   d. Wall Boxes:
   1) Product: IS-WBCA Stainless Steel Wall Mount Box with Blue Assistance
      Signage and a Light Cage.
      a) Lettering: Reflective lettering on both sides of box.
      b) Beacon/Strobe: Blue beacon/strobe mounted on top enclosed in a
         vandal resistant cage.
      c) Material: 12-gauge stainless steel.
      d) Surface Mounting: 4 inch (102 mm) depth, ADA compliant.
      e) Voltage: 24V DC.
      f) Current: 200mA.
      g) Operating Temperature for Strobe: -40 to 65 degrees C (-40 degrees
         F to +149 degrees F).
      h) Service: Vandal and weather resistant.
         SS-2RA-R emergency/assistance substations.
3. EXECUTION

a. Examination
   1) Examine areas to receive video security communication system.
   2) Notify Architect of conditions that would adversely affect installation or subsequent use.
   3) Do not begin installation until unacceptable conditions are corrected.

b. Installation
   1) Install video security communication system in accordance with manufacturer's instructions at locations indicated on the Drawings.
   2) Mount equipment plumb, level, square, and secure.
   3) CAT-5e/6 Cables:
      a) Run cables from and homerun to one central location where CEU will be installed.
      b) Maintain twists of cable pairs to point of termination or no more than 0.5 inch (13 mm) untwisted.
      c) Do not remove more than 1 inch (25 mm) of jacket when terminating cables.
      d) Cable Bends:
         • Make gradual bends of cable, where necessary.
         • Do not make bends of cable sharper than 1 inch (25 mm) radius.
         • Do not allow cable to be sharply bent or kinked at any time.
      e) Cable Ties: Dress cables neatly with cable ties using low to moderate pressure.
      f) Cross-connect cables, where necessary, using CAT-5e rated punch blocks and components.
      g) Do not splice or bridge cables.
      h) Cable Pulling:
         • Pull cable with low to moderate force.
         • Do not use oil or other lubricants not specifically designed for cable pulling.
      i) Keep cables as far away from potential sources of EMI as possible.
      j) Do not tie cables to electrical conduits or lay cables on electrical fixtures.
      k) Cable Supports:
         • Install proper cable supports a maximum of 5 feet (1524 mm) apart.
         • Do not support cables by ceiling tiles.
      l) Label Cable Termination Points: Use unique number for each cable segment.
      m) Testing Cables: Test installed cable segments with cable tester.
      n) Jacks: Install jacks to prevent dust and other contaminants from settling on contacts.
      o) Cable Slack:
         • Leave extra slack on cables, neatly coiled-up in ceiling or nearest concealed place.
         • Leave a minimum of 1 foot (305 mm) of cable slack at door station side and a minimum of 10 feet 3048 mm) of cable slack at CEU side.
      p) Do not install cables taught.
q) Grommets: Protect cables with grommets where passing through metal studs or other items that could damage cables.

r) Do not mix TIA/EIA 568A and 568B wiring on same installation. Use TIA/EIA 568B wiring throughout installation.

s) Staples:
   - Do not use staples that crimp cables tightly.
   - Do not use T-18 and T-25 cable staples.

t) Use firestop cables that penetrate firewalls.

u) Use plenum-rated cables where mandated.

c. Adjusting
   1) Adjust integrated security and communication system for proper operation in accordance with manufacturer's instructions.
   2) Demonstration and Training
      a) Demonstration:
         - Demonstrate that integrated security and communication system functions properly.
         - Perform demonstration at final system inspection by qualified representative of manufacturer.
      3) Instruction and Training:
         a) Provide instruction and training of Owner's personnel as required for operation of integrated security and communication system.
         b) Provide hands-on demonstration of operation of system components and complete system, including user-level program changes and functions.
         c) Provide instruction and training by qualified representative of manufacturer.

d. Protection
   1) Protect installed integrated security and communication system from damage during construction.

I. Door Contacts/switches
   1. Provide recessed door contacts/switches as shown on the drawings. Contacts shall be 3/4 inch and have wire leads of sufficient length for splices to be made in wiremold box or mud type box located adjacent to door. Provide GE model #1078C or approved equal for interior doors. Provide DPDT contacts for all exterior doors, GE model #1076-D or approved equal.
   2. In event that circumstances prevent the use of recessed contacts in some locations, surface contacts may be used, subsequent to approval of Architect.
   3. Wiring for door contacts shall be concealed.
   4. Door contacts shall not be wired in series with exception of double doors which may be wired to panel as single door location.
   5. There shall be no splices in door frames or jambs. Door contact connections shall be made in wiremold or mud switch box located adjacent to door.

J. Hardware Support
   1. The Systems Integrator shall perform scheduled maintenance services on all systems and equipment as specified in this section.
   2. Components and parts that are found to be defective, have failed operationally or which exhibit signs of near term failure will be identified during each preventive maintenance inspection or test. If the component or part is covered under a current Systems Integrator
or factory warranty, said part or component will be replaced at no charge to CUSTOMER including labor during normal business hours.

3. For any equipment requiring repair or replacement that is not covered, an estimate will be prepared and submitted for approval on a reimbursable basis and repair authorization shall be issued in writing by an authorized representative of the CUSTOMER before proceeding with the work.

K. Response Time

1. Should an emergency arise, the Systems Integrator personnel will assess the situation either by phone or remote diagnostics, or both, and will determine the required course of action with the CUSTOMER.

2. On-Site Response Time: If it is determined that a site visit is required, the Systems Integrator personnel will arrive at the affected premises within four (4) hours of the request of the CUSTOMER.

PART 3 - EXECUTION

3.1 GENERAL

A. Verify the exact location prior to bid of all items that may be indicated and determine exact location of all electrical items that are not indicated on the Drawings.

B. Include the cost of all work including sub-letting of any work that may be required to complete the work indicated in order to avoid work stoppages and jurisdictional disputes. The work to be sublet shall conform with precedent agreements and decisions of record. Jurisdictional assignment shall be a responsibility under this Section's contractual obligation.

C. Do not install equipment and materials which have not been reviewed by the Architect. Equipment and materials which are installed without the Architect's review or without complying to comments issued with the review shall be removed from the project when so instructed by the Architect. No payment will be made for unapproved or removal if it is ordered removed. The Installer shall be responsible for any ancillary costs incurred because of its removal and the installation of the correct equipment and materials.

D. Obtain detailed information on installation requirements from the manufacturers of all equipment to be furnished, installed or provided. At the start of construction, check all Contract Documents including all Drawings and all Sections of the specifications for equipment requiring electrical connections and service and verify electrical characteristics of equipment prior to roughing.

E. Equipment and systems shall not be installed without first coordinating the location and installation of equipment and systems with the General Contractor and all other Trades.

F. Any and all material installed or work performed in violation of above requirements shall be re-adjusted and corrected by the Installer without charge.

G. Refer to all Drawings associated with the project, prior to the installation or roughing-in of the electrical outlets, conduit and equipment, to determine the exact location of all outlets.
H. After installation, equipment shall be protected to prevent damage during the construction period. Openings in conduits and boxes shall be closed to prevent the entrance of foreign materials.

I. Home runs indicated are not to be combined or reduced without written consent from the Architect.

J. All connections to equipment shall be made as required, and in accordance with the approved submittal and setting drawings.

K. Delivery, Storage and Handling:
   1. Deliver, store, protect and handle products in accordance with recommended practices listed in Manufacturer's Installation and Maintenance Manuals.
   2. Deliver equipment in individual shipping splits for ease of handling, mount on shipping skids and wrap for protection.
   3. Inspect and report concealed damage to carrier within specified time.
   4. Store in a clean, dry space. Maintain factory protection or cover with heavy canvas or plastic to keep out dirt, water, construction debris, and traffic. Heat enclosures to prevent condensation. Meet the requirements and recommendations of NFPA 70B and the Manufacturer. Location shall be protected to prevent moisture from entering enclosures and material.
   5. Handle in accordance with NEMA and the Manufacturer's recommendations and instructions to avoid damaging equipment, installed devices and finish.
   6. The equipment shall be kept upright at all times. When equipment has to be tilted for ease of passage through restricted areas during transportation, the Manufacturer shall be required to brace the equipment suitably to insure that the tilting does not impair the functional integrity of the equipment.

L. Site Observation:
   1. Site observation visits will be performed randomly during the project by the Architect. Reports will be generated noting observations. Deficiencies noted on the site visit reports shall be corrected. All work shall comply with the Contract Documents, applicable Codes, regulations and local Authorities whether or not a particular deficiency has been noted in a site visit report.
   2. Be responsible to notify the Architect ten working days prior to closing in work behind walls, raised access floors, ceilings, etc., so that installed work can be observed prior to being concealed.
   3. Work concealed prior to observation and correction of deficiencies shall be made accessible for review at the discretion of the Architect. Bear all costs for allowing worked to be reviewed.
   4. Areas shall stay accessible until deficiencies are corrected and accepted. Notify the Architect when all deficiencies are corrected. Return reports with items indicated as corrected prior to re-observation by the Architect.

3.2 WORK

A. Loose materials shall not be stored on-site. A "gang box" is acceptable to be placed in a location agreeable to the Owner and the General Contractor. The Installer is responsible for all equipment and materials and for their delivery until the system is deemed complete and accepted by the Owner.

B. Any ceilings, walls, floors, furniture, equipment, furnishings, etc., damaged by the work of this Section shall be replaced, or at the Owner's option, repaired with similar materials, workmanship and quality.
C. Clean and touch up all equipment, materials and work sites at the completion of work in each area.

D. Certain portions of the work area may be occupied during construction. Determine which areas and schedule work accordingly and include necessary premium time.

E. Make sure necessary provisions to provide continuous service of all existing systems throughout all occupied areas.

3.3 SEALING OF PENETRATIONS AND OPENINGS

A. Environmental Seals
   1. Provide seals on raceways exposed to widely different temperatures, as in refrigerated or cold storage areas. Install seal to prevent circulation of air from warmer to colder sections through the raceway.
   2. Provide seals under device plates for outlets on walls between conditioned and non-conditioned spaces.
   3. Provide outlet plate gasket seals at all work area outlets on interior and exterior walls.

B. Smoke and Fire Stopping Seals
   1. Firestopping is performed under Section 078400.

3.4 CABLE SUPPORTS

A. Provide strain relief hardware for backbone cables at each floor level as they pass from one floor to the next.

B. Provide hook and loop (Velcro) cable wraps at all panels, equipment racks and cabinets. Cable ties are specifically prohibited.

C. Cable ties for horizontal cables shall be secured with minimum required compression in order to secure the cables properly without impeding the signal transmission rating (geometry) of the cable. Hook and loop (Velcro) cable wraps may be used in lieu of cable ties for copper cables only. Cable-ties are specifically prohibited for fiber optic cables.

D. When pathways are not provided or specified, provide J-Hook supports from the building structure as required for cable runs to the cable drop location. Maximum distance between supports shall be five feet (1500mm) depending on the structural elements of the building. Maximum number of cables per support shall be thirty. Provide additional supports as required when cable quantities exceed thirty and to maintain required bending radius of cables. Cables installed exposed or in areas subject to abuse (below 10 feet (3m) above finished floor) or in accessible areas shall be installed in conduit.

E. All cables shall be supported directly from building structure. Under no circumstance shall cable be installed using cross bracing, plumbing/sprinkler pipes, ceiling systems or any other system that is not a specifically approved method to independently support cables. Cables shall not be allowed to rest on ceiling tiles, duct work, piping, etc. Supports shall be provided as required in order for cables to avoid contact with any other building system. Bundle cables in groups by Room.
3.5 CABLE PROTECTION

A. Provide bushings in all metal studs and the like where cables will pass through. Bushings shall be of two (2) piece construction with one piece inserted through the opening and the second piece locking it into place. Single piece bushings with locking tabs or friction fit are specifically prohibited.

B. Cables to be installed in existing enclosed open bays or furred spaces where conduit stubs are not provided, shall be protected from chafing or any damage. The Installer shall verify that the warranty shall not be violated before installing any cabling in these locations.

C. Provide cutting, coring, sleeves and bushings and seal as required at all penetrations.

D. Fiber optic backbone cables shall be installed in inner duct.

E. Cables damaged during installation shall not be repaired. They shall be completely replaced with new cable.

3.6 INSTALLATION

A. All cabling shall be installed in conduit where indicated on plans, or shall be installed open using other methods, approved by architect, such as J-Hooks, cable tray & snake tray.

1. Install wiring, per manufactures recommendations.
2. All wiring shall be new, concealed in pipe where exposed.
3. Install wiring for detection and signal circuit as specified. Make wiring connections to new or existing door hardware devices as required

B. All conduits, raceways, innerduct, etc. shall have pull strings remaining after cable is pulled.

C. Impedance and Level Matching:

1. Carefully match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

D. Control Circuit Wiring:

1. Install control circuits in accordance with NFPA 70 and as indicated. Provide number of conductors as recommended by system manufacturer to provide control functions indicated or specified.
2. All housings are to be located as specified and shown on drawings.
3. Make installation in strict accordance with approved manufacturer's drawings and instructions.
4. The Installer shall provide necessary transient protection on the AC power feed, all station lines leaving or entering the building, and all central office trunks. All protection shall be as recommended by the equipment supplier and referenced to earth ground.

E. Splices, Taps, and Terminations:

1. Make splices, taps and terminations on numbered terminal punch blocks in junction, pull, and outlet boxes, terminal cabinets and equipment enclosures.
2. Identification of Conductors and Cables:
   a. Use color coding of conductors and apply wire and cable marking tape to designate wires and cables so all media are identified in coordination with system wiring diagrams.
F. Weatherproofing:
   1. Provide weatherproof enclosures for items to be mounted outdoors or exposed to weather.

3.7 GROUNDING

A. General:
   1. The Telecommunications systems comprising of cable tray, snake tray, equipment cabinets, racks and non-current carrying metallic parts shall be grounded according to the Electrical Code.
   2. In general, the grounding shall be as specified, as indicated on the Drawings and as required by the Electrical Code and Local Authorities.

3.8 INTEGRATED SECURITY SYSTEM TESTING

A. Security Management System
   1. Test in accordance with manufacturer’s security management systems testing procedures.

3.9 TRAINING

A. As a minimum training sessions shall consist of the following:
   1. General project information and review shall be by the General Foreman or Superintendent of the Trade.

B. The Owner and Maintenance Manual material shall be bound in 3-ring binders and indexed. On the edge of the binder provide a clear see-through plastic holder with a typed card indicating the Project name, the Architect's name, the installer's name and the Volume number (e.g., Vol. No. 1 of 2).

C. Provide name, address and telephone number of the manufacturer's representative and service company for all items supplied so that the source of replacement parts and service can be readily obtained.
   1. Include copies of manufacturer's and installer's warranties and maintenance contracts and performance bonds properly executed and signed by an authorized representative.
   2. Include copies of all test reports and certifications.

3.10 CLEANING UP

A. Upon completion of all work, and testing, thoroughly inspect all exposed portions of the installation and completely remove all exposed labels, markings, and foreign material.

B. The interior of all boxes and cabinets shall be left clean; exposed surfaces shall be cleaned and plated surfaces polished.

C. Repair damage to finish surfaces resulting from work under this Section.

D. Remove material and equipment from areas of work and storage areas.

E. All equipment shall be clean from dirt, dust, and fingerprints prior to final acceptance.
F. Touch up all damaged pre-finished equipment using materials and methods recommended by the Manufacturer.

3.11 PROJECT CLOSEOUT

A. Provide close out submittals as required herein and in SECTION 010400 – PROJECT COORDINATION including the following close out submittals.

1. Operation and Maintenance Manuals
2. Record Drawings.
3. Test Reports.

B. Obtain written receipts of acceptance close out submittals submitted. Receipts shall specifically detail what is being delivered (description, quantity and specification section) and shall be dated and signed by firm delivering materials and by the Owner’s Representative.

END OF SECTION